RECORD OF DECISION

AVTEX FIBERS

OPERABLE UNIT 7

SUPERFUND SITE

Front Royal, Warren County, Virginia

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I. DECLARATION

AVTEX FIBERS SUPERFUND SITE

FRONT ROYAL, WARREN COUNTY, VIRGINIA

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DECLARATION

Site Name and Location

Avtex Fibers Superfund Site
Front Royal, Warren County, Virginia
CERCLIS ID Number VAD0070358684

The Avtex Fibers Superfund Site has been divided into ten Operable Units which are described in detail in Section 4.0 (Scope and Role) of this Record of Decision ("ROD"). This ROD is for Operable Unit 7 ("OU7") consisting of Viscose Basins 9, 10, and 11, Groundwater and Surface Water.

Statement of Basis and Purpose

This decision document presents the Selected Remedy for OU7 at the Avtex Fibers Superfund Site ("Site") located in Front Royal, Warren County, Virginia, which was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA") 42 USC §§ 9601, et seq., as amended, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300, as amended. The Selected Remedy is Alternative C (Basin Capping, Groundwater Extraction and Leachate Removal),which is described in detail in Section 11.0 (Selected Remedy).

This decision document explains the factual and legal basis for selecting the remedial action for OU7. The information considered or relied upon in making this decision is contained in the Administrative Record for this Site.

The Virginia Department of Environment Quality ("VADEQ") concurred with the selected remedy in a letter dated December 30, 2009.

Assessment of the Site

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Description of the Remedy

The remedial action described here comprises the final remedy for the Site. Manufacturing operations conducted at the Site included disposal of waste viscose in basins that are leaching contaminants to groundwater. OU7 is one of several management units within the Avtex Fibers Site and consists of groundwater, surface water and Viscose Basins 9, 10, and 11, which contain a highly concentrated carbon disulfide leachate with a high pH which is considered to be a principal threat waste. This remedial action is part of on-going clean-up activities at this Site. The buildings, sewers, sulfate and fly ash units are currently being addressed by Time-Critical and Non-Time-Critical Response Actions. Other viscose basins (Viscose Basins 1 through 8), plant area soils, and the existing wastewater treatment plant are being addressed by the OU10 ROD.

The contaminant plume emanates from Viscose Basins 9, 10, and 11 and has migrated in the direction of groundwater flow in bedrock to the southwest, beneath the South Fork Shenandoah River. Carbon disulfide and arsenic were detected in wells on the west side of the South Fork Shenandoah River. Currently, water is provided to two permanent residences and two seasonal property owners. There is no current exposure to the contaminated groundwater.

The Selected Remedy for OU7 (groundwater, surface water and Viscose Basins 9, 10, and 11) is Alternative C, which is estimated to cost $30.3 Million. The components of the selected remedy are described in detail in Section 11.0 (Selected Remedy) of this ROD. The primary components of the selected remedy are:

1. Installation of a low permeability cap over Viscose Basins 9, 10, and 11.

2. Construction and operation of a groundwater extraction and treatment system to meet both the risk-based and ARAR based in-situ cleanup standards.

3. Construction and operation of a wastewater treatment plant.

4. Evaluation of the basins and extraction and treatment of the leachate to meet performance standards.

5. Characterization, removal, and disposal of impacted sediments associated with seeps adjacent to Viscose Basins 9 and 10, and OU7 soils located outside Viscose Basins 9, 10, and 11.

6. Implementation of Institutional Controls.

7. Provision of water to impacted property owners on west side of the South Fork Shenandoah River.

8. Post-closure monitoring and maintenance.

9. Annual sampling of surface water, sediments and biota in the South Fork Shenandoah River to determine if there are decreasing trends in the concentration of contaminants.

Under the Selected Remedy, human and ecological exposure to the viscose materials will be significantly reduced, as will contaminant loading to the groundwater. Highly concentrated leachate will be removed and the reduction in infiltration due to the low permeability cover will substantially reduce the mobility of residual contamination. Additionally, future uncontrolled discharge of contamination to the river will be prevented and further plume migration precluded. Groundwater will be pumped and treated until the clean-up levels are achieved.

Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment).

Because the OU7 remedy results in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted every five years to ensure that the remedy is, or will be, protective of human health and the environment pursuant to CERCLA Section 121 (c) and 40 C.F.R § 300.430(f)(5)(iii)(C). The first five year review was triggered by the date that onsite construction began for OU2 and OU3. The fourth five-year review for this Site is scheduled for March 2013.

Data Certification Checklist

The following information is included in the Decision Summary of this ROD. Additional information can be found in the Administrative Record for this Site.

ROD CERTIFICATION CHECKLIST	
Information	Location/Page Number
Chemicals of concern and their respective concentrations	Section 5.9/21
Baseline risk represented by the chemicals of concern	Section 7.0/25
Clean-up levels established for chemicals of concern and the basis for these levels	Section 8.0/33
How source materials constituting principal threat are addressed	Section 7.1.2/27
Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of	Section 6.0/24 Section 11.2.10/53

groundwater used in the baseline risk assessment and the ROD	
Potential land and groundwater use that will be available at the Site as a result of the selected remedy	Section 11.4/54
Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected	Section 11.3/54
Key factors that led to selecting the remedy	Section 11.1/46

K Hodgkiss 1/13/10

Kathryn A. Hodgkiss, Acting Director Date
Hazardous Site Cleanup Division
EPA Region III

II. DECISION SUMMARY

AVTEX FIBERS SUPERFUND SITE

FRONT ROYAL, WARREN COUNTY, VIRGINIA

1.0 SITE NAME, LOCATION AND DESCRIPTION

The Avtex Fibers Superfund Site is located at 404 Kendrick Lane in Front Royal, Warren County, Virginia. Figure 1 shows a map of the property from which the contamination emanated (the "former Avtex property"); it occupies approximately 440 acres. The Randolph Macon Academy is located along the eastern property boundary. The former General Chemical plant is located along the northwest border of the Site. Residential areas are located to the east, south, and north of the property boundaries. The South Fork Shenandoah River is located along the western portion of the property.

Rayon fibers were produced at the Site from 1940 until it closed in 1989. The production facilities were located on the eastern portion of the Site (east of the Norfolk Southern Railroad tracks) and the disposal area was located on the western portion of the Site (west of the railroad tracks).

The Comprehensive Environmental Response, Compensation, and Liability Information System ("CERCLIS") identification number for this Site is VAD0070358684.

The U.S. Environmental Protection Agency ("EPA") is the lead agency for Site activities and Virginia Department of Environmental Quality ("VADEQ") is the support agency.

This action, OU7, addresses groundwater, surface water, and Viscose Basins 9, 10, and 11. This is the final action for the Site; EPA does not anticipate the need to select additional remedial actions for the Site.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Operations at the Site began in 1940, when American Viscose opened a rayon production plant. In 1963, American Viscose sold the plant and property to FMC Corporation ("FMC"), and, in 1976, the plant and property were sold by FMC to Avtex Fibers-Front Royal, Inc. ("Avtex"). Rayon fibers were continually produced until the plant closed in 1989. Polyester and polypropylene were also produced over short periods of time.

In 1982, the Commonwealth of Virginia detected carbon disulfide in residential wells located across the South Fork Shenandoah River. In 1984, EPA proposed that the Site be addressed under the federal Superfund program. Between 1986 and 1988, Avtex conducted an investigation of the source and extent of the carbon disulfide in groundwater. The investigation determined that waste viscose containing carbon disulfide was leaching from three of the eleven viscose basins (Viscose Basins 9, 10, and 11). In 1988, EPA issued a ROD that called for pumping and treating the groundwater beneath and downgradient of Viscose Basins 9, 10, and11. This remedy was subsequently suspended pending a Site-wide investigation.

Shortly after the 1988 ROD was issued, Avtex shut down the facility. After the plant shut down in 1989, EPA initiated response actions to ensure there would be no uncontrolled releases of hazardous substances or other threats to human health and the environment. Reactive and dangerous materials were left in tanks, piping, and buildings, when Avtex shut down the facility. Preventing a release became the highest priority. Since no one was being exposed to contaminated groundwater, EPA suspended and deferred the implementation of the 1988 ROD while focusing on removal efforts to control potential releases. In the several years following the plant's shutdown, EPA responded to various emergency and time critical conditions present at the Site. In 1993 and 1994, EPA and FMC conducted a Site-wide Remedial Investigation of buildings, sewers, waste disposal areas, on-site soils and groundwater to assess the environmental condition of the Site.

The work done at Superfund sites may be divided into smaller manageable phases called operable units ("OUs"). Over the last 20 years numerous removal and remedial activities at the Site have been conducted to address threats to human health and the environment as outlined below in Table 1.

	Table 1	
OU/Removal Action	Description	Status
1	Groundwater - ROD #1 issued on 9/30/88	Suspended and deferred to OU7
2	PCB Contaminated Soil – ROD #2 issued on 9/28/90	Completed January 1992
3	Acid Reclaim Building – ROD#2 issued on 9/28/90	Completed September 1993
4	Site Security – ROD#2 issued on 9/28/90	Completed September 2002
5	Drum material – ROD#2 issued on 9/28/90	Completed September 1994
6	Investigation of Buildings	Suspended and deferred to Time Critical Removal Action (TCRA)
7	Groundwater, Surface Water and Viscose Basins 9, 10, and 11	Current ROD
8	Areas B (open lot) and C (former parking lot) – ROD #3 issued on 9/29/00	Being addressed through a Conservation Easement
9	Ecological Investigation and Risk Assessment. Risks are being addressed under ongoing Non-Time-Critical Removal Action (NTCRA) #1; the ongoing activities under ROD#4 (OU10 ROD) for Plant Area Soils, Viscose Basins 1 through 8, New Landfill, and Waste Water Treatment Plant (WWTP); and OU7 Groundwater, Surface	Being addressed under several actions

	Table 1	
OU/Removal Action	Description	Status
	Water and Viscose Basins 9, 10, and 11 (Current ROD)	
10	Plant Area Soils, Viscose Basins 1 through 8, New Landfill, and WWTP – ROD#4 (OU10 ROD) issued on March 10, 2004	Remedial Action is ongoing.
TCRA	Investigate buildings – work is either completed or being addressed under ROD#4 (OU10 ROD) or NTCRA #2	Complete or being addressed under other actions
NTCRA #1	Basins – includes Sulfate Basins 1 through 5, Fly Ash Basins, Fly Ash Stock Pile, and WWTP.	On-going
NTCRA #2	Remaining Buildings and Sewers	On-going – all the buildings have been demolished and the sewers are in the final stages of being removed. In the process of addressing several subgrade structures and associated contamination, as well as an area of contaminated soils.

In 1999, EPA and FMC entered into a comprehensive Consent Decree, which incorporated work for the Time Critical Removal Action – Buildings, OU10 ROD, both of the Non-Time Critical Removal Actions, OU7, and Site Security and Maintenance.

The remedy to be implemented at OU7, the subject of this ROD, consisting of groundwater, surface water and Viscose Basins 9, 10, and 11, is the final action for the Site.

The Feasibility Study Work Plan for OU7 was approved in 2000. The 1993-1994 Site-wide investigation, coupled with recent data collected during the Feasibility Study ("FS"), supports the selection of the remedy for OU7. The Feasibility Study Report ("FS Report") was completed in July 2009.

2.1 Waste Disposal Practices

Operations at the Site generated three major waste types that were disposed at the Site. The first type was generated when the metal-bearing wastewater from the production process was treated with lime in the WWTP; the sludge generated by that treatment was placed in five sulfate basins.

The second waste stream was fly ash generated from the combustion of coal in the onsite power plant. Fly ash was disposed of in four fly ash basins and one stock pile. These waste disposal areas were addressed as part of NTCRA#1.

The third waste stream was waste viscose, a highly alkaline, carbon disulfide-rich, cellulosic material that was disposed in eleven onsite basins. Eight of these basins (Viscose Basins 1 through 8) were addressed in the OU10 ROD issued in March 2004. The remaining three basins, Viscose Basins 9, 10, and 11, are being addressed as part of this ROD (Figure 2).

2.2 Groundwater/Surface Water

In 1994, a report summarizing the findings of the Remedial Investigation ("RI") was prepared. Since then, groundwater samples were collected, additional groundwater monitoring wells were installed, and groundwater pumping tests were conducted to determine the extent of groundwater contamination and evaluate remediation technologies. Groundwater and surface water, which includes the South Fork Shenandoah River, are being addressed as part of this ROD.

3.0 COMMUNITY PARTICIPATION

The Avtex Fibers RI summary report, FS Report, Human Health Risk Assessment, and other documents relating to the Site, were made available to the public. They are located in the Administrative Record, which was available at the following locations:

EPA Records Center
1650 Arch St.
Philadelphia, PA 19103
(215) 814 – 3123 (for assistance)

Samuels Public Library
538 Villa Avenue
Front Royal, Virginia
(540) 635 – 3153

The Administrative Record was also available at http://www.epa.gov/arweb, and at the Administrative Record link on the sidebar of the U.S.EPA Region 3 Hazardous Site Cleanup Division Homepage at http://www.epa.gov/reg3hscd.

The notice of availability of these documents was published in the Northern Virginia Daily on August 27, 2009. In addition, EPA mailed a fact sheet summarizing the Agency's preferred remedial alternative for the Site to over 400 area residences and businesses.

From August 27, 2009 to September 28, 2009 EPA took public comment on the remedial alternatives presented in the FS Report, the Proposed Plan and the other documents contained in the Administrative Record for the Site. On September 22, 2009, EPA held a public meeting to discuss the Proposed Plan and accept comments. A transcript of this meeting is included in the Administrative Record. The summary of significant comments received from the public and EPA's responses are included in the Responsiveness Summary, which is part of this ROD.

4.0 SCOPE AND ROLE

The OU7 Remedial Action is part of on-going clean-up activities at this Site. As with many Superfund sites, the environmental problems at the Avtex Site are complex. As a result, EPA has organized the Site into separate management units that are being addressed in both the removal and remedial programs. The other active management units include:

- Time-Critical and Non-Time Critical Removal Actions ("TCRA" and "NTCRA") Buildings. The TCRA Buildings covers the disposal of certain building debris and accumulated wastes, decommissioning of three carbon disulfide tanks, and other activities pertaining to the buildings and are being conducted as removal activities as selected in the Removal Action Memorandum dated March 17, 1995, as modified by the Removal Action Memorandum dated September 29, 1997, and were further described in Pollution Reports ("Polreps") Nos. 817, 865 and 888. The NTCRA Buildings includes the decontamination of buildings and removal of sewers. These actions were presented to the public and response actions were selected by EPA through the issuance of the December 2001 Action Memorandum. The response actions for the TCRA and NTCRA Buildings units are being implemented, and are expected to be completed in 2011;

- NTCRA-Basins. The closure of the sulfate sludge basins, fly ash basins, and fly ash stockpile were addressed in the January 2000 Action Memorandum. The final design was approved in March 2001. Basin closures are estimated to be over 50 percent complete and are expected to be finished in 2013;

- OU-10 consists of Viscose Basins 1 through 8 and the existing wastewater treatment plant. The remedy for Viscose Basins 1 through 8 is estimated to be about 90 percent complete, and the existing wastewater treatment plant will be addressed when it is no longer needed to treat Site storm water.

The actions selected by EPA in this document constitute a comprehensive approach for addressing all of the environmental problems at OU7 of the Site. EPA expects that the removal actions and remedial actions taken at the Site to date and the remedial action selected by EPA in this document will address the risks posed by the Site. The action selected by EPA at this time and the actions already completed are expected to be the final actions necessary to address the risks from the contamination at the Site. In the event that future buildings are constructed over or near the groundwater contaminated plume, EPA will require additional action if groundwater vapor intrusion presents an unacceptable risk.

5.0 SITE CHARACTERISTICS

5.1 Geologic Setting

Front Royal is located in a transitional area between the Valley and Ridge and Blue Ridge physiographic provinces. The Valley and Ridge province is characterized by gently rolling, linear to arcuate hills and broad valleys, whereas the Blue Ridge province contains mountainous terrain with V-shaped valleys and steep ridges. The bedrock in the Front Royal area is the result of emplacement of Precambrian and Early Paleozoic crystalline high-grade metamorphic rocks of the Blue Ridge thrust sheet over Cambrian and Upper Ordovician sedimentary rocks.

The primary stratigraphic units at the Site are the Ordovician-age Martinsburg and Edinburg/Oranda formations. Although the Martinsburg Formation has been differentiated into two lithologic units in the past, based on borehole data, it appears that the lower unit, consisting of carbonaceous shale interbedded with sequences of argillaceous limestone and shale, is the dominant lithology underlying the Site. Examination of core from boreholes at the Site indicates that calcite veining is ubiquitous in the Martinsburg Formation, as are blebs of pyrite and chalcopyrite. The Martinsburg Formation underlies the majority of the Site and Catlett Mountain area. The Edinburg/Oranda Formation, comprising fissile shale and micrite interbedded with argillaceous limestone, is present only on the eastern portion of the Site in the former plant area, and the southernmost part of Catlett Mountain. The Edinburg/Oranda Formation has been observed throughout the borehole of Well 301 and in the upper portions of several boreholes (Well 302, Well 303, Viscose #2), where it appears to have been thrust over the younger Martinsburg Formation along the Frontal Thrust Forelimb fault.

In the bedrock beneath the Avtex Site, several thrust faults have been identified and mapped using rock core obtained from boreholes at the Site.

The primary structural features at the Avtex Site are thrust faults and folds. Two northeast-southwest-striking low-angle reverse vaults were mapped in the bedrock beneath the Avtex Site: the Frontal Thrust fault, and the Forelimb Thrust fault. The Frontal Thrust fault juxtaposes the Edinburg-Oranda Formation across the Martinsburg Formation. The fault strikes north 25° - 30° east and dips to the southeast at 25° - 30°.

The Frontal Thrust fault is present in boreholes from Well 302, Well 303, and the Viscose #2 production well, and outcrops at the west bank of the South Fork Shenandoah River at the intersection of State Route 619 and Catlett Mountain Road. A breccia zone has also been mapped in several coreholes beneath the Forelimb Thrust Fault. The orientation of this planer feature appears to be similar to that of the Forelimb Thrust.

The surface expression of the Forelimb Thrust fault is present just to the northwest of sulfate basin 1. The Forelimb Thrust fault has been intercepted in all of the coreholes at the Site, and generally strikes northeast-southwest, approximately parallel in strike and dip to the Frontal Thrust fault. Both faults represent a zone of intense shearing and brecciation, and calcite veining; however, cores show no evidence of groundwater flow along these lines.

Two levels of folding have been observed at the Avtex Site: regional-scale megascopic folds with amplitudes greater than 200 feet and wavelengths greater than 500 feet, and mesoscopic folds, which are more local in extent and can be observed in outcrop and core.

The formation of cleavage in the Martinsburg Formation is axial planar and trends parallel with the bedrock strike. Cleavage is well developed, and in outcrop, it appears that fracturing at the outcrop scale is primarily associated with the cleavage. However, examination of rock core indicates that most fractures are associated with bedding plane partings rather than cleavage. Thus, fracturing along bedding-parallel cleavage planes in rock outcrop is the result of weathering of clay and micaceous minerals exposed to the atmosphere, whereas fracturing in the rock at depth is primarily along bedding planes.

Joint sets are also present in the Martinsburg Formation. These joints are subvertical to vertical, and trend northwest-southeast, perpendicular to the northeast-southwest-striking folds and thrust faults. The combination of joints and strike-parallel folding and faulting has produced a regional trellis drainage pattern that is apparent from fracture trace analysis. In addition to the smaller creeks, the course of the South Fork Shenandoah River is likely influenced by the regional fracture systems. Along the west side of the Avtex Site, the South Fork Shenandoah River likely follows a northwest-southeast-trending fracture system while south of the Site it appears to follow a northeast-southwest-trending fracture system.

5.2 Hydrogeology

Two naturally occurring geologic units are important in the Site hydrogeology: the overburden and the bedrock. Groundwater occurs in both units, although only water from the bedrock is used in the adjacent rural areas for domestic water supply. The overburden, which is mapped regionally as alluvium and colluvium associated with the South Fork Shenandoah River, is composed primarily of clay and silt. The overburden typically ranges from 3 to 25 feet thick and is laterally discontinuous in some areas. Due to the fine-grain texture of the overburden materials, the overburden has low vertical permeability and likely inhibits the migration of chemicals from the viscose and sulfate basins.

Throughout the majority of the Site, the bedrock underlying the overburden beneath the Site is the Ordovician-age Martinsburg Formation. Its thickness is reported as 3,000 feet; thus, it extends to great depths beneath the Site and is the only bedrock unit of hydrogeological importance beneath the Site. Seismic refraction data indicate that the bedrock surface slopes toward the South Fork Shenandoah River, and that erosional features are present on the top of the bedrock in several locations onsite.

Previous investigations have classified groundwater monitoring wells in four different depth zones at the Site: overburden, shallow bedrock (top of bedrock to 100 feet below ground surface), intermediate bedrock (100 to 180 feet below ground surface), and deep bedrock (greater than 180 feet below ground surface). All depth zones are interconnected.

5.3 Groundwater

The structural geology of the bedrock has significant influence on the movement of groundwater and chemicals beneath the Site. Groundwater flow in the bedrock is controlled by the degree of fracturing and faulting associated with the thrust faults and folds previously described.

Overall the lateral groundwater flow direction in the overburden is westerly towards the South Fork Shenandoah River. However, due to the structural controls of the bedrock, the groundwater flow paths in bedrock are likely oriented more to the southwest, along strike. The orientation of bedding plane fractures is the primary controlling feature defining the flow direction in the bedrock aquifer.

5.4 Surface water

The primary surface-water feature is the South Fork Shenandoah River, which bounds the western margin of the Site. The river bed of the South Fork Shenandoah River adjacent to the Site, and for a distance downstream of the Site, consists mostly of exposed bedrock and largely lacks sedimentary deposits. Sampling of river sediments during the RI required extensive searching and the samples were ultimately collected from near-shore or shoreling locations. The depth of the river varies according to precipitation but is typically shallow (i.e., approximately one to three feet in depth in the summer). The groundwater investigation determined that groundwater is both discharging to, and migrating under, the South Fork Shenandoah River.

Surface water from the Site generally drains toward the river, which has historically received storm water runoff and WWTP discharges from the Site. Currently, all surface water runoff that is potentially impacted by Site contaminants is collected and managed through the WWTP prior to discharge to the South Fork Shenandoah River. Storm water runoff from areas of the Site that were not impacted by Site activities or that have been remediated are not treated in the WWTP; such runoff discharges directly to the River. The South Fork Shenandoah River flows northeast to its confluence with the North Fork. The river is used recreationally for fishing and boating adjacent to the Site. The Virginia Department of Health currently has fish consumption advisories and restrictions due to PCBs for the South Fork Shenandoah River downstream from the Route 619 bridge crossing near Front Royal to the confluence with North Fork Shenandoah River, for the North Fork Shenandoah River from the mouth of the river upstream to Riverton Dam, and for the Shenandoah River from the confluence of the North and South Forks to the Virginia/West Virginia state line.

5.5 Ecological and Terrestrial Resources

FMC's consultant conducted a survey of the Site to identify the ecological and terrestrial resources. The results of the survey are discussed below.

Ecological Resources

The Site has been highly disturbed, and the aquatic and terrestrial species observed on the Site recently by the Smithsonian Conservation and Research Center and in 2000 by Wetland Studies and Solutions, Inc. are early successional species that respond to newly exposed areas and the lack of predation. No threatened, endangered, or unexpected (atypical or unusual for region) reptiles or amphibians were detected at the Avtex Site. Species commonly observed at the Site include:

- Reptiles - Eastern Rat Snake, Eastern Painted Turtle, and Eastern Snapping Turtle;
- Amphibians - American Bullfrog, American Toad, Fowler's Toad, Spring Peeper, Gray Treefrog, Green Frog, and a single Pickerel Frog (along the South Fork Shenandoah River);
- Mammals – White-Tailed Deer, Eastern Gray Squirrel, Eastern Cottontail, and Eastern Fox Squirrel;
- Birds – American Crow, European Starling, Yellow-rumped Warbler, Field Sparrow, Red-winged Blackbird, Canada Goose, Mallard, American Black Duck, Turkey Vulture, and Ring-billed Gull.

In addition, the Smithsonian Conservation and Research Center identified several species of migratory birds on Site including the brown creeper (*Certhia americana*) and golden-crowned kinglet (*Regulus satrapa*), Virginia Species of Concern, and the state threatened bald eagle (*Haliaeetus leucocephalus*), as well as the fish species, American eel(*Anguilla rostrata*).

Terrestrial Resources

The roughly 200-acre portion of the Site east of the railroad right-of-way has been significantly modified by the construction, and eventual demolition, of an industrial facility. The former industrial facility property is cleared and possesses very limited, mostly early successional, terrestrial resources.

The approximate 200-acre portion of the Site west of the railroad right-of-way also has been significantly modified due to the construction of waste management basins. However, the subsequent closure of the waste management basins has created restored terrestrial grassland habitats planted with native, warm-season grasses. One of the former disposal basins, 5, was converted into a pond, which provides aquatic habitat.

The floodplain area along the South Fork Shenandoah River contains a tree canopy dominated primarily by Box-elder and American Sycamore, with numerous saplings of Box-elder in the understory. There are several non-native, potentially invasive plant species growing on the Site, including Autumn Olive, Empress Tree, Common Mullen, Japanese Honeysuckle, Japanese Switchgrass, and Multiflora Rose. The area south of former Sulfate Basin 5 is dominated by Pin Oak, American Sycamore, American Elm, Eastern Cottonwood, and Box-elder.

Wetlands and Wetlands Onsite

A study conducted in August 2000 identified five separate drainage ways as jurisdictional waters of the U.S.

The first drainage way is the unnamed tributary that borders the northern edge of the property between the Avtex Site and the Honeywell Superfund site. The tributary originates as palustrine emergent wetland located in an upland successional field on the eastern side of the railroad tracks. Water from this wetland area is conveyed by a box culvert under the railroad tracks and flows westerly in the stream channel along the property boundary and discharges into the South Fork Shenandoah River. Vegetation is predominantly herbaceous dominated by Broad-leaf cattail, with lesser amounts of other species (Joint-head arthraxon, Awnless Begger-Ticks, Cardinal flower, and Alleghany Monkey-Flower). Vegetation along the downstream portion of the stream in the northernmost portion of the Site is strongly upland dominant, with scattered young Eastern Red Cedar and a diverse herb layer including a variety of grasses.

The second drainage way originates in a series of palustrine emergent wetlands located on the northeastern side of the former fly ash stockpile. Groundwater discharge appeared to be the primary source of hydrology for these wetlands. This intermittent stream with emergent wetlands flows westerly along the northern berms of viscose basins 9 and 11 and discharges into sulfate basin 1. Historically, this stream had discharged directly into the South Fork Shenandoah River.

The third drainage way was considered to be primarily an intermittent stream, with several small areas of palustrine forested wetland adjacent to the stream. Historically, the stream and/or wetland originated on the eastern side of the railroad tracks across from the northern end of the former fly ash basin 6, passed through a culvert under the railroad tracks, and then flowed westerly into the South Fork Shenandoah River. However, over the years of industrial activity, the flows on the western side of the railroad have been modified appreciably. The majority of the water now flows in a man-made ditch parallel to the western side of the railroad tracks and adjacent to the former fly ash basin 6, and then travels southwesterly in a series of braided channels into the South Fork Shenandoah River.

The fourth drainage way originates in the swale north of former fly ash basin 6 and flows southwesterly along the drainage way between the former sulfate basins 4 and 5 into the South Fork Shenandoah River. It was necessary to entirely reconstruct this drainage way during the implementation of NTCRA #1 for the adjacent basins.

The fifth drainage way is an unnamed intermittent stream that flows in a deeply incised channel along the north side of Luray Street that is on the most southernmost point of the Avtex Site. The stream originates offsite to the southeast.

5.6 Surface Features

The Site can be divided into two areas separated by the railroad line that runs north-south through the Site. This railroad line separates the former plant area to the east from the waste disposal areas to the west (Figure 2). The plant area, which is relatively flat, included the main plant buildings and other facilities that were used at the Site during the manufacturing process. All of the buildings have been removed. The waste disposal area includes 26 land impoundments that were used for the disposal of plant process wastes. The WWTP and associated facilities are also located on the west side of the rail road tracks. With the exception of Viscose Basins 9, 10, and 11, all of the former waste disposal impoundments have been, or are being, addressed under other removal and/or remedial actions.

5.7 Sources of Contamination

Viscose Basins 9, 10, and 11 received waste viscose produced from the rayon manufacturing process from 1958 to 1983. The waste viscose material contained within the basins has a basic pH and high levels of carbon disulfide, metals, and dissolved salts – constituents that were consistently present in groundwater samples collected from monitoring wells located southwest (i.e., down strike) of the basins and across the river in the Rivermont Acres subdivision (Figure 3).

Although 11 basins were used to dispose of waste viscose at the Site, these three basins appear to be the primary contributors to groundwater contamination and are currently the primary source of the carbon disulfide plume. The other eight basins (Viscose Basins 1 through 8) contained different types of wastes and have entirely different characteristics than Viscose Basins 9, 10, and 11. Basin 11 rests directly on bedrock, whereas a thin alluvial clay layer (ranging in thickness from 2 to 15 feet) separates the majority of the waste materials in Viscose Basins 9 and 10 from the bedrock.

Viscose Basins 9, 10 and 11 were constructed by excavating close to, if not into, bedrock, and building up berms. Viscose Basins 9, 10, and11 are estimated to contain 3.1, 2.6, and 2.6 million cubic feet of viscose sludge, respectively (i.e., a total of 306,419 cubic yards). Viscose sludge thickness within the basins ranges from approximately 20 feet in Viscose Basins 9 and 10 to approximately 15 feet in Viscose Basin 11.

The consistency of the viscose sludge ranges from "soft" (similar to mashed potatoes) to hard and rubber-like. In general, the lower portions of the basins contain predominantly hard viscose, and the softer material is in the upper portions of the basins. Voids, ranging from several inches to several feet, are present throughout the viscose sludge. The collapse of near-surface voids is very likely responsible for the differential settling that has resulted in the hummocky topography of Viscose Basins 10 and 11.

The sludge was analyzed for a variety of geotechnical parameters. The sludge is not a soil, and, therefore, many soil property tests could not be performed or were inconclusive. The sludge is hydrated, containing over 80% water– the majority of which is bound (i.e., does not drain freely under gravity). The soft viscose solids were found to compress considerably, resulting in the release of water. The sludge is relatively impermeable and thus the fluid flow through the sludge is most likely along fractures and through voids.

The majority of contaminants of concern ("COCs") migration occurs vertically from the base of the viscose basins to groundwater in the bedrock aquifer. The overburden materials have very limited thickness downgradient of the viscose basins. This, coupled with the density effects driving migration of the leachate downward from the basins to the bedrock aquifer, results in minimal lateral migration to the overburden materials.

5.8 Leachate

Viscose Basins 9, 10, and 11 contain three types of leachate: orange leachate at depth; green leachate that is present in shallow portions of the basins; and a mixture of orange and green. The orange leachate is a dense aqueous phase liquid ("DAPL"), very high in pH (12-13), with very high concentrations of carbon disulfide (approximately 4,200 mg/L) and arsenic (0.845 mg/L). Lower pH (about 7.0) green-colored leachate is present in the upper portions of these basins and contains much lower concentrations of carbon disulfide (26.5 mg/L). A transitional (or mixed) zone is present between the orange and the green leachates. The chemical properties of the mixed leachate vary from those of the green leachate to those of the orange leachate. A laboratory study indicated that the carbon disulfide in the orange leachate is bound in an aqueous complex which is released as the pH of the water is reduced. Table 2 provides a summary of the chemical profiles of the leachates.

The majority of the COCs that were found in groundwater (Table 3) were also found in the Viscose Basins 9, 10, and 11 leachates. The exceptions were bis(2-ethylhexyl) phthalate, pentachlorophenol, and cadmium. Although these four compounds have been identified in several locations on the Site, the specific source of the groundwater contamination for these four compounds has not been determined.

The basins are estimated to contain a total of 8.2 million gallons ("Mgal") of green leachate, 3.0 Mgal of mixed leachate, and 1.8 Mgal of orange leachate. It is possible that additional leachate could be generated from the soft viscose under the weight of a cap. Outflow of leachate to groundwater is estimated to be on the order of 700,000 gallons/year.

EPA considers the viscose leachate to be a source material and a principal threat waste due to toxicity, mobility, and difficulty to contain, as demonstrated by the contaminated groundwater plume originating at Viscose Basins 9, 10, and 11. Because of its high pH (12-13) and potential to release carbon disulfide and hydrogen sulfide gases upon acidification, the orange leachate is a characteristically hazardous waste under Code of Federal Regulations 40 CFR §261.22(a)(1) and 40 CFR §261.23(a)(4). The mixed leachate has the potential to release sulfide gases when acidified. As a result, there is a potential that the mixed leachate may be a characteristically hazardous waste due to its reactivity characteristic. Field and laboratory observations suggest that the green leachate is unlikely to release hydrogen sulfide at levels of concern under current and future conditions; it is not certain whether any particular batch of extracted green leachate would be classified as characteristically hazardous.

5.9 Solids

The viscose solids were found generally to increase in carbon disulfide concentration and pH with depth in a pattern similar to that observed for the basin leachates. The hard viscose solids at depth were found to contain elevated concentrations of carbon disulfide. A special analysis designed to quantify both the free and bound fractions of carbon disulfide in the viscose material indicated that the viscose materials at depth (the hard viscose) contain a substantial fraction of bound carbon disulfide that is not readily extracted and measured using standard analytical techniques. The bound carbon disulfide likely represents carbon disulfide that is still chemically bound in the viscose matrix as cellulose xanthate and was released as the cellulose xanthate decomposed in response to the low pH digestion of the analytical method. The soft viscose materials in the uppermost portions of the basins were found to contain lower carbon disulfide concentrations and not a substantial fraction of bound carbon disulfide.

The majority of the COCs (Table 3) that are found in groundwater were also found in the viscose solids. A notable exception was antimony, which was not detected in the viscose solids, but was detected in groundwater (up to 747 ug/L) and leachate samples (up to 647 ug/L). In addition, arsenic was detected in only 1 sample of the 19 viscose solid samples. This sample contained an arsenic concentration of 2.1 mg/kg. The general absence of arsenic and antimony at elevated concentrations in the viscose solids suggests there is a source of antimony and arsenic other than the viscose solids.

Fly ash, which contains appreciable concentrations of these metalloids, represents the most probable source. Leaching tests of fly ash (samples collected from below Viscose Basin 9) and bedrock confirmed that both the orange and the green leachate have significant potential to leach arsenic from samples of fly ash and bedrock. For several years, run off from a former adjacent fly ash stockpile drained directly to Viscose Basin 10, likely carrying particulate fly ash into the basin. In addition, fly ash was used to construct roads atop Viscose Basins 9, 10, and 11 to permit access for sampling. Finally, fly ash has historically been used as fill material at the Site.

The elevated pH of the leachate may also contribute to leaching of arsenic from the surrounding overburden and bedrock, thereby contributing to the elevated levels of arsenic in the groundwater plume.

5.10 Nature and Extent of Contamination

5.10.1 Groundwater and Viscose Basins 9-11

The highest concentration of COCs typically occurs within a zone of high-salinity, high pH groundwater (the "carbon disulfide plume"). This zone of groundwater extends southwest from Viscose Basins 9, 10, and 11 along the geologic strike of the shale bedrock that underlies the Site, beneath the South Fork Shenandoah River, and to the west side of the river (Figure 4). This groundwater plume exhibits the same general chemical properties that characterize the leachates in Viscose Basins 9, 10 and 11, such as elevated concentrations of carbon disulfide, total dissolved solids ("TDS"), chemical oxygen demand ("COD"), and arsenic. Field and laboratory measurements demonstrate that water in the plume contains a substantial fraction of dissolved sulfides with little or no dissolved oxygen.

While carbon disulfide and arsenic are pervasive throughout the groundwater plume, there are a few other COCs which are found intermittently at various locations. Sampling since 2000 indicated mercury was detected only in several wells located on the berm between Viscose Basins 9 and 10 and the berm between Viscose Basins 10 and 11. These wells monitor groundwater in the overburden, and in the shallow bedrock and intermediate bedrock depths. These detections are most likely due to some isolated disposal of material containing mercury in the viscose basins. Mercury was not detected in any other well at concentrations at or above drinking water standards.

In the immediate vicinity of Viscose Basins 9, 10, and 11, the carbon disulfide plume occurs in overburden groundwater and in all three of the bedrock well depth zones. However, southwest of the basins, the most concentrated portion of the plume is generally limited to wells completed within the intermediate and deep depth zones of the bedrock aquifer. At the South Fork Shenandoah River, the width of the plume in the shallow depth zone is only 200 feet while in the intermediate and deep depth zones it is approximately 600 to 700 feet wide. The plume does not appear to have migrated significantly below a depth of 400 feet.

In March 2008, sampling of the sentinel Well #604 located down strike of the carbon disulfide plume contained 1.06 ug/L of carbon disulfide, which is below EPA's Region III Risk Based Concentration of 1,000 ug/L. Samples taken from residential wells installed in the Catlett Mountain area, southwest of the Site, show no evidence of the plume in this area. The low concentration of carbon disulfide in Well #604 and the lack of contamination in any of the Catlett Mountain domestic wells indicate that the plume has not migrated significantly to the southwest beyond the current monitoring network. Figure 3 shows the location of the groundwater monitoring wells and Figure 4 shows the location of the carbon disulfide contaminated groundwater plume.

The available data suggest that, while other Site facilities such as the fly ash basins and sulfate basins, may be sources of dissolved solids to groundwater, they are not significant sources of metals or organic contaminants to bedrock groundwater.

5.10.2 Surface Water

There are three potential mechanisms for Site COCs to impact the South Fork Shenandoah River: storm water runoff, groundwater discharge, and discharge of wastewater treatment plant ("WWTP") effluent. Historically, storm water flows and WWTP discharges represented a primary pathway for chemical discharge to the river. These chemical loads have historically led to elevated concentrations of metals and polychlorinated biphenyls ("PCBs") in the river. However, since 1990, virtually all Site waters have been directed to the WWTP for treatment.

A significant PCB release from the Avtex facility occurred on December 22, 1985, as a result of a transformer explosion at the powerhouse complex, and approximately 500 kg of PCBs were released into the storm water network to the river. Additional suspected sources of the PCB contamination in the South Fork Shenandoah River include a PCB spill adjacent to the Polymer Building, and historical discharges from the Wastewater Treatment Plant which occurred when the manufacturing facility was operating. The river bed of the South Fork Shenandoah River consists mostly of bedrock and lacks sedimentary deposits. The ecological investigation found low concentrations of PCBs in fingernail clams downstream of the Avtex Site. PCBs are not a contaminant of concern in the groundwater.

Groundwater discharge to the river is another potential contaminant migration pathway. A study conducted in 1988 and a separate study conducted in 1999 concluded that river water quality would not be degraded by groundwater discharge, primarily because groundwater flow rates are very low relative to flow rates in the South Fork Shenandoah River.

In August 2001, during an extremely low river stage, evidence of seepage was observed in the river coincident with the footprint of the shallow bedrock groundwater plume, indicating that the plume is discharging to the river. The seepage areas had stained sediments and visibly diminished submerged aquatic vegetation. Biased river water and sediment samples were collected from observed seepage areas. The analytical results demonstrated that this discharge had no measurable effect on the river water quality, and affected only the sediment quality.

Sampling results indicated that sediment metals concentrations are not elevated within seepage areas. Sediment metals concentrations in the 2001 sampling are similar to, or lower than, those observed in the 1997 EPA sampling. The 1997 sampling found that metals concentrations in sediments had not been changed by Site releases. The same conclusion was reached in 2001.

However, concentrations of several volatile organic compounds ("VOCs") were detected in the sediment samples from the seepage areas. Carbon disulfide and chlorobenzene were detected at concentrations up to 1,500 and 520 ug/L respectively. These chemicals are associated with the groundwater plume located in bedrock immediately below the seeps. Due to the generally poor sorption properties of these VOCs, it is likely that these chemicals are in fact associated with the sediment pore water rather than the sediment solids.

Although there has been a release to the South Fork Shenandoah River and evidence of some localized seepage, the water quality of the river is not currently adversely affected by the Site. Two current pathways for potential contaminant migration to the river are the WWTP discharge and groundwater seepage. River sediments show effects in localized seepage areas where the contaminated groundwater plume enters the River. In addition, the sediments contain residual PCBs from historical releases.

6.0 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

6.1 Land Use

In 1998, the Town of Front Royal and Warren County officials, along with FMC, engaged Northern American Realty Advisory Services to prepare a comprehensive plan for the Site's redevelopment and reuse. An approved master plan emerged from that process that provided for the development of the Site into a mixed-use commercial, light industrial, office, and open space project. Since then, areas of reuse have been further refined to either commercial/light industrial (160 acres in the former plant area), active recreation (33 acres of the former Stump Park), conservancy and open space (240 acres located between the railroad tracks and the South Fork Shenandoah River) and a public park on the west side of the South Fork Shenandoah River (70 acres). Enforceable limitations on the future land uses have been placed on the Avtex property. A Conservation Easement held by the Lord Fairfax Soil and Water Conservation District and the Valley Conservation Council was filed on December 7, 1999. The Economic Development Authority ("EDA") holds title to the property.

Land use surrounding the Site consists of a private school located along the eastern property boundary, and residential areas located east, south and north of the property boundaries. In addition, the former General Chemical facility plant is located along the north/northwest boundary of the property.

6.2 Resource Use

Lateral groundwater flow through the overburden materials and bedrock is generally westward toward the river, where groundwater discharges. At depth, the groundwater passes beneath the river. Data obtained during bedrock coring and geophysical borehole logging indicate that groundwater flow in the bedrock aquifer occurs along fractures, joints, and cleavage. The bedrock aquifer is used in the area west of the river for domestic water supply. Potable water in the area on the east side of the river is provided by the Town of Front Royal.

In 1982, carbon disulfide was detected in domestic wells in Rivermont Acres, a subdivision identified on Figure 1, across the river from the Avtex Site. The carbon disulfide plume passed beneath the river because of density differences between the plume of contamination and groundwater. Avtex purchased all the properties with domestic wells within the potentially degraded area of Rivermont Acres. Currently, the EDA holds the title to the properties previously purchased by Avtex. Parcels of land not held by the EDA in Rivermont Acres currently do not have drinking water wells.

Currently, FMC supplies water to two permanent residences and one seasonal residence outside the known plume of contamination, but located in Rivermont Acres.

The primary surface water feature at the Site is the South Fork Shenandoah River. Surface water from the Site generally drains west toward the river, which has historically received the treated effluent from the WWTP at the Site. The South Fork Shenandoah River flows northeast to its confluence with the North Fork Shenandoah River. The South Fork Shenandoah River is used recreationally for fishing and boating.

7.0 SUMMARY OF SITE RISKS

The investigation of OU7 included analyses to estimate the human health and ecological hazards that could result if contamination at the Site is not addressed. These analyses are commonly referred to as risk assessments and identify existing and future risks that could occur if conditions at the Site do not change. A baseline risk assessment estimates what risks the Site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action.

The baseline human health risk assessment for OU7 groundwater evaluated the potential risk due to oral, dermal, and inhalation exposures to groundwater within the contaminated plume for potential future onsite and offsite residential groundwater users.

A separate baseline human health risk assessment was prepared for five areas of the Site, one of which was Viscose Basins 9, 10, and11. For Viscose Basins 9, 10, and11, the risk assessment evaluated the potential risk for an onsite adolescent trespasser/recreator due to exposure to viscose basin solids.

In human health risk assessments, risks are determined for carcinogens and noncarcinogens. For carcinogens, risks are generally expressed as the likelihood of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of Site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes, such as smoking or exposure to too much sun. EPA's generally acceptable risk range for Site-related exposures is 1×10^{-4} to 1×10^{-6}.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., life-time) with a reference dose ("RfD"). An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient ("HQ"). An HQ less than or equal to 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are not likely. The Hazard Index ("HI") is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action. An HI less than or equal to 1 indicates that toxic noncarcinogenic effects from all contaminants are not likely. An HI greater than 1 indicates that Site-related exposures may present a risk to human health.

A summary of those aspects of the human health risk assessments which support the need for remedial action, as well as a summary of the ecological risk assessment, is discussed below.

7.1. Summary of Human Health Risk Assessment

Exposure to wastes within Viscose Basins 9, 10, and 11 would result in potential risks. The contaminated groundwater plume poses potential risks associated with the use of groundwater. These risks were evaluated in human health risk assessments that are described below.

7.1.1 Viscose Basins 9, 10, and 11

The human health risk assessment evaluated the risks associated with potential exposure to viscose solids. Risks were calculated for a potential current trespasser/recreational user or a future user for the basins for three exposure pathways: ingestion of soil, dermal contact with soil, and inhalation of soil particulate matter. Chemical analysis of viscose material collected from boreholes throughout the viscose basins were compared to EPA Region III risk-based concentrations ("RBCs") for industrial exposure, and only arsenic exceeded its RBC. The calculated excess cancer risk from arsenic was below 1×10^{-6} (the lower end of EPA's acceptable risk range). Human exposure to the solid material in the viscose basins does not present an unacceptable risk. The leachate contained within the basins is highly concentrated with contaminants and constitutes a principal threat. The basins are located directly on bedrock with little or no overburden material. The contaminants in the leachate are mobile with a preferential downward flow mechanism. The elevated pH of the leachate may act to leach arsenic from the surrounding overburden and bedrock materials.

7.1.2 Principal Threat Waste

EPA characterizes waste on-site as either principal threat waste or low-level threat waste. The concept of principal threat waste and low-level threat waste, as developed by EPA in the NCP, is applied on a site-specific basis when characterizing source material. "Source material" is defined as material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, to surface water, to air, or that act as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile, which would present a significant risk to human health or the environment should exposure occur.

EPA has identified the leachates in Viscose Basins 9, 10, and 11 as a principal threat waste. The characteristics of the viscose basin leachates vary with depth (Table 2). The shallower leachate is termed "green leachate" and is less concentrated. The deeper leachate is termed "orange leachate" and has higher concentrations of contaminants. A transitional (or mixed) zone is present between the orange and the green leachates.

The orange leachate is a dense aqueous-phase liquid that is contained in the deeper portions of Viscose Basins 9 and 10. The liquid is miscible with water and has a very high pH (12-13). Orange leachate also contains highly elevated concentrations of carbon disulfide (approximately 4,200 mg/L), COD (approximately 33,500 mg/L), and an average arsenic concentration of 0.845 mg/L.

The green leachate has a lower pH (around 7.0), is present in the upper portions of these basins and contains much lower concentrations of carbon disulfide (approximately 26.5 mg/L) and COD (2,800 mg/L), with an average arsenic concentration of 0.024 mg/L.

The three basins are estimated to contain a total of 8.2 million gallons (Mgal) of green leachate, 3.0 Mgal of mixed leachate, and 1.8 Mgal of orange leachate.

Because of its high pH (12-13) and potential to release carbon disulfide and hydrogen sulfide gases upon acidification, the orange leachate is classified as a characteristically hazardous waste under 9VAC20-60-261. The mixed leachate has the potential to release sulfide gases when acidified. As a result, there is the potential that the mixed leachate may be a characteristically hazardous waste as well. Field and laboratory observations suggest that the green leachate is unlikely to release hydrogen sulfide at levels of concern under current and future conditions; it is not certain whether any particular batch of extracted green leachate would be classified as characteristically hazardous.

Several potential health and safety concerns were identified during the investigation of Viscose Basin 9 including: vapor hazards from hydrogen sulfide and carbon disulfide, explosion and fire hazards from hydrogen sulfide and carbon disulfide, and splash and dermal contact hazards from liquid with Viscose Basin 9 (historical pH range of 9 – 12.5). Due to the potential hazards, several precautions were required for workers at the Site, including Level B Personal Protection Equipment (supplied air with chemical resistant clothing) within the Primary Exclusion Zone and vapor detection badges for hydrogen sulfide and carbon disulfide.

The Viscose Basin No. 9 Pilot Test Excavation was summarized in the Supplemental Field And Laboratory Data Report for OU7, dated December 2001. This report summarized observations during the excavation. Hydrogen sulfide was measured in air at up to 34 parts per million ("ppm"), with sustained levels of 3 ppm at a location 25 feet downwind of excavation activities. Carbon Disulfide was detected at up to 4 ppm at one monitoring station.

In addition to being an explosion hazard, hydrogen sulfide and carbon disulfide are highly toxic via the inhalation route under both acute and chronic exposure conditions. These compounds are also absorbed through the skin upon direct contact. Toxic effects related to hydrogen sulfide and carbon disulfide include irritation to the eyes and respiratory system, dizziness, gastrointestinal disturbances, reproductive effects, apnea, central nervous system effects, convulsions and coma. For the protection of workers, the American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value of 10 ppm for both hydrogen sulfide and carbon disulfide.

Under baseline conditions at the Site (that is, in the absence of remediation), at the measured concentrations, hydrogen sulfide and carbon disulfide pose a clear inhalation risk to future receptors contacting Viscose Basin 9. To illustrate this, under future residential and commercial worker exposure scenarios, the potential risks associated with the measured concentrations of hydrogen sulfide and carbon disulfide are presented below. Note that to mitigate potential threats, U.S.EPA typically considers taking action when combined Hazard Quotients ("HQ") exceed one (for similar target organs).

Observations during test pit excavation	Hazard Quotient
Hydrogen Sulfide Spike (34 ppm):	Future residential HQ = 21,850 Future commercial worker HQ = 5,215
Hydrogen Sulfide Sustained (3 ppm)	Future residential HQ = 1,928 Future commercial worker HQ =460
Carbon Disulfide (4 ppm)	Future residential HQ = 17 Future commercial worker HQ = 4

7.1.3 Groundwater

The baseline human health risk assessment evaluated a hypothetical future residential scenario for exposure to groundwater located both on and off of the former Avtex property. The risk assessment assessed potential risk that exists without cleanup or institutional controls.

All three possible routes of exposure to groundwater – ingestion, dermal absorption, and inhalation of volatile compounds – were included in the risk assessment. Twenty-three contaminants of potential concern ("COPCs") were carried through the exposure and toxicity assessment, and the risk calculations.

Tables 4 and 5 present the summary of non-cancer and cancer risk estimates for all exposure pathways for adults and children. The tables also present the risk estimates for non-carcinogens whose HQ contributes to an organ-specific HI greater than one or carcinogenic risk estimates greater than 1×10^{-5}. For non-cancer health effects via the ingestion and dermal pathways, three constituents (carbon disulfide, arsenic, and mercury) contribute over 90% of the calculated risk, with- mercury being the most significant contributor (70% of calculated risk). For non-carcinogenic health effects through the inhalation pathway, mercury was also the main risk driver, contributing approximately 70% of the risk. Under a future land use scenario for residential exposure to onsite/offsite groundwater, the total HI summed across all pathways and all constituents is 290 for adults and 410 for children.

It is worth noting that although mercury is a significant risk driver for groundwater, it is detected (at concentrations above MCLs) in only two wells (Well 116 and Well MW-03), which are located in the berm between Viscose Basins 9 and 10 and the berm between Viscose Basins 10 and 11.

The total cancer risk for potential exposure associated with domestic use of water is 8.2×10^{-3} for the future adult resident and 4.8×10^{-3} for the future child resident, resulting in a cumulative lifetime cancer risk of 1.3×10^{-2} as shown in Table 6. For carcinogenic effects via the ingestion and dermal pathways, arsenic contributes virtually all of the carcinogenic risk (99%). None of the volatile COPCs are carcinogenic via the inhalation pathway.

Therefore, unacceptable risks have been identified for exposure to groundwater located both on and off the former Avtex property.

The Conservation Easement places restrictions on the types of temporary and permanent buildings and structures that can be built or maintained in the area covered by the disposal basins, including Viscose Basins 9, 10, and 11 and the area west of the South Fork Shenandoah River. At the present time there is no definitive guidance on the evaluation of groundwater vapor intrusion on land without permanent structures. Therefore, EPA has not determined if groundwater vapor intrusion presents an unacceptable future risk at the Site. If such a determination is made, EPA can address this new information in another decision document.

7.2 Summary of Ecological Risk Assessment

EPA conducted an ecological risk assessment in 1999 to evaluate the potential risks to ecological receptors from the COCs. The COCs were those compounds that had been determined to pose a potential ecological risk during the Preliminary Ecological Risk Assessment. The COCs were metals, polynuclear aromatic hydrocarbons ("PAHs"), PCBs, and carbon disulfide. The EPA ecological assessment focused on the following two scenarios: exposure to contaminants in the sediment, water, and biota from onsite basins; and exposure to soil and biota collected from onsite areas. The biological testing and sampling conducted were designed to determine the impacts from all the Site areas (fly ash basins, sulfate basins, viscose basins, and other onsite areas). Based on the types of habitats present at the Site, the risk assessment evaluated the potential risk to benthic invertebrate communities: piscivorous (belted kingfisher), worm eating birds (American woodcock), carnivorous birds (red-tailed hawk), carnivorous mammals (red fox and mink) and omnivorous animals (raccoon).

The EPA Ecological Risk Assessment, dated February 1999, concluded that potential ecological risks exist at the Site.

There is a potential risk to ecological receptors in the South Fork Shenandoah River. All redbreast sunfish (*Lepomis auritus*) samples collected from the South Fork Shenandoah River for the 1999 Ecological Assessment had detectable levels of PCBs. Metals were also detected in sunfish tissue, including: chromium (1.4-2.7 milligrams per kilogram ("mg/kg")), copper (1.5-10 mg/kg), mercury (0.69-0.81 mg/kg), and zinc (67-80 mg/kg). Elevated concentrations of PCBs and other contaminants in fish may impact fish populations and the health of fish-eating birds and mammals. Based on food chain exposure models using sunfish concentrations from the South Fork Shenandoah River and a literature review for No Observed Adverse Effects Levels, hazard quotients ("HQs") for belted kingfisher (*Ceryle alcyon*; piscivorous birds) were above 1 for PCBs, copper, and mercury in the South Fork Shenandoah River. HQs for smallmouth bass (*Micropterus dolomieu*) in the South Fork Shenandoah River were above 1 for PCBs and HQs for mink (*Mustela vison*; carnivorous mammal) and raccoon (*Procyon lotor*;

omnivorous mammal) were above 1 for mercury and PCBs at some South Fork Shenandoah River locations. As explained in the ERA, a HQ>1 indicates that exposure to a contaminant has the potential to cause adverse effects in the organism.

Sediment and water samples collected from the South Fork Shenandoah River did not impact the survival of benthic macroinvertebrates. However, fingernail clams were accumulating PCBs. The highest concentrations of PCBs were detected in the clams collected downstream of the Wastewater Treatment Plant discharge. A past transformer explosion, a PCB spill adjacent to the Polymer Building, and historical discharges from the Wastewater Treatment Plant when the plant was operating are the suspected sources of the PCB contamination in the South Fork Shenandoah River. Ten-day sediment toxicity tests with the midge (*Chironomus tentans*) were conducted using surface sediment from the South Fork Shenandoah River and on-Site basins and ponds. Survival was significantly reduced at one location along the river (59% survival) compared to the control, although there was no difference in growth. Survival of the midge and amphipod (*Hyallela azteca*) was significantly reduced as a result of exposure to on-Site basins sediments.

Fish samples collected from the South Fork Shenandoah River contained elevated levels of PCBs. These levels increased in a downstream direction and ingestion of these fish may impact carnivorous fish, piscivorous birds, and piscivorous mammals.

7.3 Conclusion of Risk Assessments

EPA has concluded that hypothetical future potential exposure to groundwater by direct contact for a residential (adult/child) receptor would result in a non-cancer hazard that exceeds the target threshold of 1 and a cancer probability that would exceed the upper bound of the cancer risk management range (10^{-4}). The total cancer risk for potential exposure associated with the domestic use of water is 8.2×10^{-3} for the future adult resident and 4.8×10^{-3} for the future child resident. The total Hazard Index summed across all pathways and all constituents is 290 for adults and 410 for children.

Air monitoring conducted during the RI revealed elevated air concentrations of hydrogen sulfide and carbon disulfide during pilot test excavations.

The sampling conducted during the RI did not confirm any impacts to the surface water in the South Fork Shenandoah River: however, the samples collected during the low river stage did identify an impact on the benthos.

The remedial action selected in this ROD is necessary to protect the public health or welfare of the environment from actual or threatened releases of hazardous substances into the environment.

8.0 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives ("RAOs") are chemical- and media-specific goals for the remedial action that are protective of human health and the environment. Seven RAOs were identified for the remediation of Viscose Basins 9, 10, and 11, groundwater, and surface water, which are discussed below:

RAO 1: Prevent human exposure (human ingestion, inhalation or dermal contact) to groundwater that contains Site related COCs that would result in unacceptable levels of risk.

Potential exposure to contaminants in the groundwater represents an unacceptable risk to human receptors. Water is currently provided to property owners on the west side of the South Fork Shenandoah River to prevent exposure to contaminated groundwater. In turn, there are no current users of groundwater affected by the contaminated ground water and thus no complete exposure pathways. Compliance with RAO 1 will ensure that potential future risks posed by offsite groundwater are mitigated.

RAO 2: Prevent human and ecological receptor exposure through direct contact with waste in Viscose Basins 9, 10, and 11.

The surfaces of Viscose Basins 9, 10, and 11 are exposed and, although the HHRA determined that the surface viscose solids do not represent a significant risk, the basins would represent a potential physical hazard to humans under the proposed future use of this area of the Site as a conservancy park. Furthermore, without engineered controls (i.e., pumping of near-surface leachates), a pathway for direct contact with the leachates, and seepage into the drainage feature north of Viscose Basins 9 and 11, would continue. Exposure to leachates under these two conditions would represent a potential risk to both human and ecological receptors. Compliance with RAO 2 will ensure that future potential risks posed by the exposed wastes and leachates in Viscose Basins 9, 10, and 11 are mitigated.

RAO 3 Mitigate the risks from the principal threat wastes in Viscose Basins 9, 10, and 11 by treatment of the leachate.

EPA considers the viscose leachate to be a source material and a principal threat waste. The National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), at 40 C.F.R. §300.430(a)(l)(iii)(A), establishes that EPA will use "treatment to address the principal threats posed by a site, wherever practicable." Principal threat wastes are those source materials that are highly toxic or mobile and cannot be reliably contained or would present significant risk should exposure occur. Compliance with RAO 3 will ensure that the source of groundwater contamination will be treated.

RAO 4: Restore the groundwater to its beneficial uses by: (1) reducing contaminant concentrations such that the cumulative excess lifetime cancer risk is less than one in ten thousand (1×10^{-4}); (2) reducing non-cancer risks to a hazard index (HI) of 1 (or less) for each specific organ; and (3) ensuring that Maximum Contaminant Levels (MCLs) for carcinogens and non-zero Maximum Contaminant Level Goals (MCLGs) for non-carcinogens are not exceeded.

Historical and on-going releases of leachates from Viscose Basins 9, 10, and 11 have resulted in a contaminated groundwater plume in the overburden and fractured bedrock aquifer underlying the Site. RAO 4 requires that groundwater be restored so that it presents no excess risk to receptors. The remedial cleanup standards are listed in Table 7. The remediation of groundwater at the Site will continue until the respective MCLs for carcinogens and MCLGs for non-carcinogens for the COCs are attained, the excess cancer risk associated with potential residential use of the groundwater is reduced to one in ten thousand (1.0E-04), and the HI is reduced to 1. Because groundwater which meets the MCLs/MCLGs for individual contaminants may not meet the risk-based standards (1.0E-04 and HI less than or equal to 1) cumulatively if multiple contaminants are present, determination of meeting the "protection of human health and the environment" RAO will be performance-based. When preliminary cleanup standards have been attained (Table 7), EPA will evaluate post- ROD data from the periodic groundwater monitoring and develop a trend analysis and risk assessment. The risk assessment will be based on an assessment of the cumulative risk across all applicable exposure routes for all COCs remaining in groundwater following achievement of the preliminary cleanup standards (i.e., MCLs for carcinogens and MCLGs for noncarcinogens). The remediation of groundwater at the Site will continue until the risk-based cleanup standards (1.0×10^{-4} and HI less than or equal to 1) are achieved.

RAO 5 Mitigate further releases to groundwater of hazardous substances from residual contamination in Viscose Basins 9, 10, and 11.

As described above for RAO 4, further releases of hazardous substances from the viscose basins due to continued leachate seepage would inhibit the restoration of groundwater to its beneficial uses.

RAO 6 Control and mitigate contaminated groundwater plume discharge to the river.

Contaminated plume discharge to the South Fork Shenandoah River has been identified in localized areas coincident with the shallow bedrock plume. Several plume constituents (VOCs) have been identified in sediments (likely pore waters). Although no measurable effect on the river water quality is evident, seepage areas had stained sediments and visibly diminished submerged aquatic vegetation. RAO 6 is intended to ensure the mitigation of uncontrolled plume discharge to the river.

RAO 7 Control the production and release of hazardous and/or noxious gases from Viscose Basins 9, 10, and 11 that represent an unacceptable risk or public nuisance.

Uncontrolled release of hazardous and/or noxious gases from Viscose Basins 9, 10, and 11 could result in detrimental health effects and/or a nuisance. This RAO will ensure that appropriate mitigation and/or control measures are taken to prevent exposures that could lead to negative health effects or public nuisance.

The selected remedial action for OU7 is consistent with the requirements of the Conservation and Environmental Protection Easement and Declaration of Restrictive Covenants recorded in the Warren County, Virginia Land Records on December 7, 1999. This easement placed certain covenants, conditions, and restrictions on use of the property that are binding and run with the land.

9.0 SUMMARY OF REMEDIAL ALTERNATIVES

The FS evaluated five alternatives. This section provides a summary of each of the alternatives and the estimated cost for each alternative in 2009 dollars. A cost summary is provided on Table 8 and the detailed cost breakdown is provided in the FS Report in the Administrative Record. Nineteen in-situ technologies were evaluated during the FS, None were effective or implementable, and therefore none are proposed as viable alternatives.

9.1 Alternative A – No Action

Under this alternative, no additional remedial measures would be implemented at the Site for OU7.

Capital Cost:	$ 0
Annual O&M Cost:	$ 0
Total Present Worth Cost	$ 0

9.2 Common Elements included in Alternatives B, C, D, and E

Alternatives B through E contain some common elements that were considered in the evaluation process. The common elements are described in the following sections.

9.2.1 Installation of a low permeability cap and cover layer over Viscose Basins 9, 10, and 11 (except Alternative E which does not include a cover).

Placement of a low-permeability cap over the basins would substantially reduce the infiltration of precipitation, which represents a significant component of the basin water balance. It is anticipated that the cap would cause the mounded conditions in the basins to dissipate with time and the hydraulic gradient from the basins to ground water to be substantially reduced – resulting in a considerable reduction in leachate and contaminant loading to overburden and bedrock groundwater.

The basin cap will be designed to meet the applicable or relevant and appropriate requirements ("ARARs") of the Virginia Solid Waste Management Regulations ("VSWMR"). The low-permeability layer will be constructed to meet the VSWMR requirements of a hydraulic conductivity less than or equal to that of any natural subsurface soils present, or a hydraulic conductivity no greater than 10^{-5} cm/sec, whichever is less. The vertical hydraulic conductivity of the overburden ranged from 9.9×10^{-6} to 9.1×10^{-9} cm/sec, with a geometric mean of 8.2×10^{-8} cm/sec.

The FS included a conceptual design for cost-estimating purposes which is described below. The actual design and construction of the low-permeability layer will be determined during the remedial design. The conceptual design components for the low-permeability cap include:

- Geotextile Liner – Prior to installing the bridging layer, a permeable high-strength geotextile would be placed over the basins to provide structural support for the bridging layer and to reduce the degree of sinking of the bridging layer materials.
- Bridging Layer – Installation of the cap would be facilitated by constructing a "bridging layer" across each basin. This bridging layer would consist of 3 to 5 feet of clean soils/gravel and would serve to permit access of heavy equipment to the basins, and to support the final cap and cover over the basins. The material would be placed atop the viscose using a tower crane equipped with a clam shell bucket. This approach would allow for relatively even application of the bridging materials on top of the viscose materials – thereby minimizing sinking and wave propagation of the viscose materials.
- Leachate Drainage Layer -- A drainage layer would be installed above the bridging layer. It is likely that some leachate will be released from the viscose solid materials as they consolidate under the weight of the bridging layer. Depending on the degree of viscose consolidation and leachate release, there is a potential that green leachate could inundate the cap/cover system. If so, a leachate drainage layer would be placed above the bridging layer. For the purpose of cost estimating, it is assumed this drainage layer would consist of a 1-foot thick layer of gravel (or similar

permeable construction material). A collection piping system would be placed within the drainage layer to allow for active collection of leachate. In addition, it is assumed that shallow wick drains would be installed extending from the drainage layer into the soft viscose to allow green leachate to migrate to the drainage layer and to facilitate consolidation of the viscose. Leachate collected by the drainage system would be conveyed to the WWTP and treated in conjunction with extracted groundwater. Both treated leachate and groundwater would be discharged to the river.

- Gas Vent Layer – A gas vent layer (1 foot gravel) would be installed for either active gas collection and treatment or passive venting to the atmosphere. For cost estimate purposes, it is assumed that active venting and treatment would be required. The need for active gas collection and treatment will be assessed during the remedial design phase. Gases collected from the vent layer would be treated, if necessary, to meet air discharge requirements using a vapor-phase catalytic granular activated carbon (GAC) reactor.
- Low Permeable Layer – Placement of a low-permeable liner consisting of low density polyethylene (LDPE) liner would be significantly less than 8.2 x 10^{-8} cm/sec.
- Surface Drainage Layer – Placement of the surface drainage layer consisting of gravel fill (approximately 1 foot thick) and fitted with horizontal drain pipes (2-inch slotted poly vinyl chloride (PVC)). This layer would capture water infiltrating through the overlying clean cover and would be graded to permit gravity flow of the collected water from the basins to a nearby Site drainage feature. Because the water collected in this layer would have only been in contact with clean cover materials, treatment of the water would not be required and the water could be discharged with other Site runoff to the river.
- Clean Cover – Placement of clean soil and topsoil cover (2 feet thick), graded to a 2 percent slope and vegetated.
- Revegetation – Revegetation of the cover with native plants.

9.2.2 Groundwater extraction and treatment to capture the groundwater plume and restore the ground water quality

Groundwater extraction wells would be installed adjacent to and downgradient of Viscose Basins 9, 10, and 11, and adjacent to the river on the east side. The specific number and locations of the wells will be determined during the remedial design phase. The extracted groundwater would be treated in an onsite WWTP (as described below) and discharged to the river. The objectives of the groundwater extraction measures would be preventing further migration of the plume, controlling plume discharge to the river, potentially creating a hydraulic separation between the basins and the bedrock groundwater, and restoring the aquifer to its beneficial uses by meeting the groundwater performance standards. Figure 5 presents a conceptual layout for the ground water extraction wells.

Extraction wells near the South Fork Shenandoah River are to be installed to: stop contaminants from discharging to the river; stop migration of contaminants underneath the river; and to draw back contaminants that have already crossed underneath the river. These objectives can readily be accomplished by design and operations of the extraction system. Extraction wells will be drilled and completed to maximize extraction of deeper contaminated groundwater and minimize capture of shallow groundwater. Pumping rates will be optimized to minimize the potential to draw water from the South Fork Shenandoah River.

Without full-scale operational data, there is some uncertainty inherent in estimating groundwater extraction requirements to achieve plume capture and restoration in a fractured bedrock system. This is particularly true with respect to groundwater on the west side of the river. To address this uncertainty, the system will operate the four extraction wells with a contingency to place a fifth extraction well on the west side of the river. If the additional well is needed, a pipeline would be installed beneath the river using horizontal drilling techniques to convey extracted groundwater to the WWTP. Additional wells beyond the five would be installed if EPA determines they are necessary to achieve the performance standards in a reasonable timeframe.

Also, one or more wells may need to be installed north of the viscose basins. The actual number and placement of extraction wells and their associated pumping rates will be determined during remedial design, and the effectiveness of the design in achieving the performance standards will be re-evaluated periodically, and modifications to the remedial design will be made if warranted. For cost estimating purposes, it was assumed that the extraction wells would operate for 30 years; a longer period may be necessary to meet the performance standards.

The delineation of the south side of the plume on the west side of the river will be completed; it is anticipated that one well will be required to complete the delineation. The location of the well or any necessary additional wells will be determined during the remedial design phase.

For the cost estimate, it was assumed that groundwater extraction would, at a minimum, involve the installation of four open-borehole, groundwater extraction wells completed to a depth of 300 to 400 feet below ground surface with an extraction rate of 100 gpm.

9.2.3 Construction and operation of an onsite wastewater treatment plant to treat extracted groundwater and leachate.

The existing WWTP is designed for the treatment of surface water and is located in the 100-year flood plain. The existing plant is not suited for the technologies required for the treatment of groundwater and leachate and is scheduled for decontamination and demolition as a component of the OU10 remedy.

Groundwater captured by the extraction system and leachate collected from the leachate drainage layer of the cap would require treatment of COD/biological oxygen demand ("BOD"), carbon disulfide, reduced sulfur species, metals (e.g., arsenic and antimony), and other organic/inorganic contaminants. A newly constructed onsite treatment system would be utilized to treat the extracted groundwater and leachate prior to discharge to the river. Because the degree of treatment is dependent on the concentration of contaminants, and the concentration of contaminants is, in turn, dependent on the leachate/groundwater mix, the specific treatment system components will be determined during remedial design. The WWTP discharge limits to the South Fork Shenandoah River will be established during the design phase and will comply with the ARARs.

9.2.4 Characterization and removal of any impacted sediments associated with seeps located adjacent to Viscose Basins 9, 10, and 11, and OU-7 soils located outside Viscose Basins 9, 10, and 11.

Historically there has been intermittent seepage into the drainage channel located immediately north of Viscose Basins 9 and 11. Samples of the sediments were analyzed in April 2009. The validated results indicate that arsenic is the only compound of concern. The remedial action will include excavation and placement of the sediments under the cap of the viscose basin if the material is non-hazardous within the meaning of 9VAC 20-60-261, and off-site disposal if the material is hazardous within the meaning of 9VAC 20-60-261. OU-7 soils located outside the basins that are not to be covered by the Viscose Basins 9, 10, and 11 cover systems will be characterized. Soils exceeding the soil cleanup standards for direct contact or the ecological standards and that are non-hazardous within the meaning of 9VAC 20-60-261 will be excavated and placed under the cap of the viscose basins; hazardous soils within the meaning of 9VAC 20-60-261will be disposed off-site at a RCRA permitted facility. Soils exceeding soil cleanup standards for groundwater protection that are not hazardous within the meaning of 9VAC 20-60-261will be disposed off-site in a Resource Conservation and Recovery Act ("RCRA") Subtitle D landfill. Confirmatory sampling of the excavated areas will be performed.

9.2.5 Institutional controls, such as land use and/or well permit restrictions

Institutional controls, such as land use and/or well permit restrictions, are necessary to:

- Prevent the installation of drinking water supply wells in the area where the groundwater contamination levels exceed MCLs for carcinogens, MCLGs for non-carcinogens and/or the selected risk-based concentrations, thus minimizing the potential for exposure to contaminated groundwater during the cleanup process.

- If EPA determines that offsite pumping may cause potential migration of the groundwater contaminated plume, EPA shall take any measures it determines are needed to prevent such offsite pumping, as necessary.

- Restrict future onsite development as necessary to protect the integrity of the basins cap(s) and the pump and treatment remedy for groundwater and leachate.

Viscose Basins 9, 10, and 11 are located on property for which the Economic Development Authority has title. The use of this property is currently governed by the Conservation and Environmental Protection Easement and Declaration of Restrictive Covenants, which require that the property not be used in any manner that interferes with the integrity of EPA's response action.

An Institutional Control Management Plan will be developed for the Site to outline appropriate institutional controls, implement the controls, and monitor the controls to ensure they are viable. To ensure the remedy is protective, institutional controls in the form of proprietary controls (e.g., conservation easement, restrictive covenant) or an informational device (e.g., deed notice) shall be implemented if needed in any area that does not have existing proprietary controls.

9.2.6 Extension of the public water system/or provision of water to impacted properties in Rivermont Acres and Fiddler's Green areas.

Currently water is provided to four property owners on the west side of the South Fork Shenandoah River. Two of these properties, furthest from the groundwater plume, are year round residents, and two property owners, closest to the groundwater plume, appear to be seasonal residents. Each alternative includes an element to either extend the public water line or provide water to impacted property owners (both current and future) until groundwater cleanup performance standards are achieved. EPA is selecting the provision of water to impacted property owners.

9.2.7 Performance of post-closure cover inspections and maintenance (except Alternative E which does not include a cover), groundwater monitoring, and treatment plant performance monitoring.

9.2.8 Annual sampling of surface water and sediments in the South Fork Shenandoah River to determine if there are decreasing trends in the concentrations of contaminants.

In addition to analysis of surface water and sediments for contaminants, the sampling plan shall include a biological component for monitoring invertebrates and fish for PCBs. Threshold levels determined by EPA to be protective of ecological receptors will be developed for inclusion in the long term monitoring plan and will be used to determine if concentrations detected in water and sediment attributed to the Site have reached acceptable levels.

9.3 Alternative B – Basin Capping and Groundwater Extraction and Treatment

Under this alternative, all of the remedial action elements discussed in Section 9.2 would be implemented. These elements consist of:

- Installation of a low permeability cap over Viscose Basins 9, 10, and 11;
- Pump and treat the groundwater to meet both the risk-based and ARAR based in-situ cleanup standards in Table 7;
- Construction and operation of a WWTP to treat extracted groundwater to meet the discharge standards;
- Characterization, removal and disposal of impacted sediments[1] associated with seeps adjacent to Viscose Basins 9 and 11, and OU-7 soils located outside Viscose Basins 9, 10, and 11;
- Implementation of institutional controls;
- Provision of water to impacted property owners on west side of river;
- Post-closure monitoring and maintenance;
- Annual sampling of surface water, sediments and biota in the South Fork Shenandoah River to determine if there are decreasing trends in the concentration of contaminants. In addition, the surface water sampling will include: sampling of the drainage way north of Viscose Basins 9 and 10 after construction of the cap under typical lower flow conditions as well as storm water sampling. This sampling will be conducted downgradient of the viscose basins.

This alternative includes the installation of a low permeable cap over the viscose basins to reduce seepage of contaminants to overburden groundwater and the bedrock aquifer. The remedy could be constructed in one to two years. Groundwater extraction would capture the groundwater plume and restore the aquifer. For purposes of cost estimating, it was assumed that 30 years of pumping and treating groundwater would be required. In addition, this alternative would include institutional control measures and long term monitoring.

The cost for Alternative B is estimated to range from $24,200,000 to $25,600,000.

9.4 Alternative C - Basin Capping, Groundwater Extraction and Treatment and Leachate Removal and Treatment

Alternative C - Basin Capping, Groundwater Extraction and Leachate Removal is the Selected Alternative for OU7 groundwater, surface water, and Viscose Basins 9, 10, and 11.

Alternative C has the same components as Alternative B, except that under Alternative C, the leachate would be extracted from Viscose Basins 9, 10, and 11. Treatment of the leachate would require a complex treatment train for the WWTP. Due to the high

[1] Sediments/soils classified as RCRA Subtitle C hazardous will be disposed of appropriately at an off-site RCRA permitted facility. Any sediments/soils which are not hazardous but exceed EPA's Region 3 Regional Screening Levels for industrial soils at a total cancer risk of 1×10^{-5}, and a total non-cancer risk for target organs specific HQ of 1 for and/or EPA's Region 3 Ecologically Protective Backfill Values will be excavated and placed into the basins under the cap, except that any such soils which exceed the standards for ground water protection will be disposed of off-site at a RCRA Subtitle D landfill.

concentrations of carbon disulfide and hydrogen sulfide, the leachate would pass through an equalization process consisting of blending with extracted groundwater to allow safe treatment in the WWTP.

The cost for Alternative C is estimated to range from $30,000,000 to $31,400,000.

9.5 Alternative D - Basin Capping, Groundwater Extraction and In-situ Treatment of Viscose Basin Solids/Leachate with Electrical Resistance Heating ("ERH")

Alternative D is similar to Alternative C with the exception that the solids and leachate in the viscose basins would be treated with ERH technology prior to capping the viscose basins. Following ERH treatment, the leachates within the basins would be removed for ex-situ treatment to address inorganic contaminates and any remaining residual contamination.

ERH is the remedial technology identified during screening that offers the best potential to treat a significant fraction of the contaminant mass associated with Viscose Basins 9, 10, and 11. Preliminary bench-scale treatability and modeling studies indicated that ERH is potentially effective for treatment of carbon disulfide, hydrogen sulfide and other organic constituents in the viscose materials. However, the effectiveness of ERH for full-scale remediation of the viscose basins remains uncertain. The high salinity of the viscose material may limit the effectiveness of the technology during full-scale implementation.

The cost for Alternative D is estimated to range from $74,200,000 to $75,600,000.

9.6 Alternative E – Ex-situ treatment of Viscose Basin Solids and Groundwater Extraction/Treatment

Remedial Alternative E involves the excavation of viscose waste from Viscose Basins 9, 10, and 11, ex-situ treatment of the viscose solids, closure of the basins in accordance with the selected ARARs, groundwater extraction and treatment of extracted groundwater and viscose basin leachate. A significant concern posed by the excavation and treatment of the viscose materials is the potential for the release of hazardous gases and hydrogen sulfide odors to the atmosphere, and the potential for a hazardous worker environment and unacceptable community exposure to hazardous gases and odors during active remediation. Alternative E would require substantial provisions to ensure that off-gas generation is limited and that off-gases are treated efficiently.

The cost for Alternative E is estimated to range from $142,500,000 to $143,900,000.

10.0 EVALUATION OF ALTERNATIVES

Evaluation Criteria

Based on data collected during the RI/FS, EPA has determined that the Avtex Fibers Site presents an unacceptable risk to human health and the environment and therefore remedial action is warranted. Alternative A does not meet the threshold criteria of protectiveness and compliance with Applicable and/or Relevant and Appropriate Regulations ("ARARs"), and is not carried through the comparison of Alternatives.

Below is a description of the nine criteria set forth in the NCP, 40 CFR §300.30(e)(9), used to evaluate each of the remedial alternatives summarized in this plan. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to the others. These nine criteria can be categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria.

Threshold Criteria

- ***Overall Protection of Human Health and the Environment*** addresses whether a remedy provides adequate protection and describes how risks are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

- ***Compliance with ARARs*** addresses how each remedy will comply with or can be modified to comply with Federal and State environmental and facility siting requirements that are applicable or relevant and appropriate.

Primary balancing criteria

- ***Long-term Effectiveness and Permanence*** refers to the ability to maintain reliable protection of potential long-term risks remaining after implementation of the remedy. Issues addressed for each alternative include the magnitude of long-term risks and the long-term reliability of the management controls (e.g., land use restrictions).

- ***Short-Term Effectiveness*** addresses the period of time needed to ensure protectiveness of human health during the construction and implementation phase of the remedial action. Key factors to be considered in this evaluation include risk to local residents, risk to Site workers and the community, and the time required to complete onsite construction work.

- ***Reduction of Toxicity, Mobility or Volume Through Treatment*** addresses the degree to which alternatives reduce the mobility, toxicity, or volume of hazardous substances through treatment.

- ***Implementability*** addresses the technical and administrative feasibility of the remedy, and the availability of services and materials to implement the remedy.

- ***Cost*** includes the estimated capital, O&M, and present worth costs.

Modifying criteria

- ***State Acceptance*** indicates whether the State concurs with, opposes, or has no comment on the selected remedy based on the review of the Record of Decision and backup documents.

- ***Community Acceptance*** is fully evaluated in the Record of Decision based on public comments received through public meetings and written comments on the Proposed Plan and supporting documents contained in the Administrative Record.

Threshold criteria must be satisfied in order for a remedial alternative to be eligible for selection. Primary balancing criteria are used to weigh trade-offs between alternatives. State acceptance and community acceptance are modifying criteria formally taken into account after public comment is received on the Proposed Plan. Provided below is a summary of the relative performance of the alternatives with respect to each of the criteria. This summary provides the basis for EPA's preliminary determination of which alternative provides the best balance of all the criteria.

The ARARs are located in Appendix A. Table 9 summarizes the comparison of each alternative against the threshold and the balancing criteria. The summary of the comparison of the remaining four alternatives are compared to the Remedial Action Objectives on Table 10.

10.1 Threshold Criteria

This section discusses the alternatives with respect to meeting the threshold criteria of protectiveness and compliance with ARARs.

No additional action would be taken under the No Action Alternative. Alternative A is not protective and does not comply with ARARs.

Alternative B would not meet either of the threshold criteria. Because this alternative would not extract or treat concentrated leachate from the viscose basins, it would not achieve RAO 3 or RAO 5. Also, without removal and/or treatment of the leachates, it is unlikely that this alternative would restore groundwater to its beneficial uses (RAO 4). Alternative B would not comply with the Virginia Solid Waste Management Regulations because it involves the management of hazardous waste (i.e., the characteristically hazardous leachate) without compliance with 9VAC 20-80-240 and 9VAC 20-80-320.

Alternatives C, D, and E would meet both threshold criteria. These alternatives would prevent human and ecological exposure to the viscose materials (RAO 2) through treatment, isolation, and/or removal and treatment/disposal, and would substantially reduce or eliminate contaminant loading to groundwater (RAO 5). These alternatives would address the principal threat wastes by treating or removing the basin leachates (RAO 3),thereby substantially mitigating further contaminant releases from the basins to groundwater (RAO 5). Furthermore, based on the reduction in the source of groundwater contamination, a more rapid decline in groundwater contaminant concentrations is expected, which would facilitate compliance with RAOs 1 and 4.

Groundwater extraction and treatment (a component of Alternatives B through E) would prevent future uncontrolled discharge of the contaminants to the river (RAO 6) and would preclude further plume migration. Of the currently available technologies, groundwater extraction and treatment is the technology that is likely to improve groundwater quality the most, and would be able to restore all of the aquifer. Because source loading from the basins would continue under Alternative B, it is unlikely that this alternative would restore the aquifer in a reasonable time frame (RAO 4). Alternatives C, D, and E would result in a substantial reduction in future contaminant loading to the aquifer and thus allow for aquifer restoration to take place. However, groundwater extraction can take a long time and substantial time would be required before complete aquifer restoration is achieved.

Alternatives B, C, D, and E would be consistent with the planned future Site use, and appropriate measures would be taken to ensure compliance with ARARs. However, compliance with air emission standards under Alternatives D and E could be somewhat difficult. There is a risk that a release of gases could occur at some point during active implementation of Alternatives D and E.

10.2 Balancing Criteria

This section discusses the alternatives with respect to meeting the balancing criteria of long-term effectiveness and permanence; short-term effectiveness; reduction in toxicity mobility, and volume; implementability; and costs.

10.2.1 Long-term effectiveness and permanence

Alternatives C through E would substantially attain the criteria of long-term protectiveness and permanence.

Alternative C would leave some contamination in place. However a substantial volume of the highly concentrated leachates would be removed. Alternative D, in situ treatment via ERH, would result in a reduction in the contaminant mass in the basins. Because the ERH technology has not been demonstrated on the field scale for viscose basin wastes, there is some uncertainty in the degree of its effectiveness.

Alternative E would remove most of the contamination, would provide the most long-term effectiveness, and would be permanent.

10.2.2 Short-term effectiveness

Alternative B would pose the lowest short term risks and would be the most effective in the short-term. Relative to Alternatives D and E, Alternative C has the lowest potential for an uncontrolled release of contaminants during implementation and provides the best short term effectiveness. Alternative D relies on collection of off-gases generated during electrical resistance heating, and, given the complexity of the gas capture process, there is some potential for a release of these gases to the surrounding environment. Controlling air releases during excavation of the viscose basin material (Alternative E) would be difficult. In addition, there is a strong possibility of not only air releases, but also explosions. Alternative E would also result in a large volume of truck traffic through the community in order to dispose of wastes, resulting in risks to the public.

10.2.3 Reduction in Toxicity, Mobility, and Volume

If ERH is as effective as bench testing indicated it could be, Alternative D would rank high in terms of reduction in toxicity, mobility and volume. Alternative D would treat the viscose basin solid material and many of the contaminants in the leachate, the remainder of which would be treated after extracting the leachate. However, there is a high level of uncertainty about the application of this technology for full field-scale treatment of the basins. Furthermore, even if effective, some residual contamination would be left in place after treatment.

Alternative E also ranks high for reducing toxicity, mobility and volume by excavating and treating the solid material and removing the leachate for treatment .

Through the treatment of the viscose basins leachates (i.e., treatment of principal threat wastes), Alternative C would result in a substantial reduction in toxicity, mobility, and volume. Although residual contamination would be left in place after the implementation of this remedy, the reduced infiltration resulting from the low-permeability cap would substantially reduce the mobility of this residual contamination. Relative to Alternatives D (if effective) and E, Alternative C ranks somewhat lower in reduction in toxicity, mobility, and volume due to the uncertainty about how much residual contamination would be left in place.

Alternative B ranks low in terms of reducing toxicity, mobility and volume through treatment because this alternative does not treat the principal threat wastes (basin leachates), nor does it treat the viscose solids.

10.2.4 Implementability

Of the four Alternatives being compared (Alternatives B through E), Alternatives B and C demonstrate the highest level of implementability because they rely on established technologies and conventional equipment. Alternative D relies on the use of ERH – a relatively innovative technology that has not been demonstrated on a full scale on viscose materials. Alternative E would probably require containment strategies during excavation to prevent the release of gases and would pose significant health and safety issues, particularly to workers.

10.2.5 Costs

With an estimated cost of $24.5 million ("M"), Alternative B is the lowest cost alternative. Alternative C is estimated to cost $30.3 M. These two alternatives are substantially less costly than Alternatives D ($74.5M) and Alternative E ($143M).

10.3 Modifying Criteria

This section discusses the alternatives with respect to the modifying criteria of state/support agency acceptance and community acceptance.

10.3.1 State/Support Agency Acceptance

The Commonwealth of Virginia has reviewed a pre-final draft of the ROD and comments from the public, and concurred with the selected remedy in a letter dated December 30, 2009.

10.3.2 Community Acceptance

From August 27, 2009 through September 28, 2009, EPA took public comment on the remedial alternatives presented in the FS Report and the Proposed Plan and the other documents contained in the Administrative Record for the Site. On September 22, 2009, EPA held a public meeting to discuss the Proposed Plan and to accept comments. A transcript of this meeting is included in the Administrative Record. The summary of significant comments received from the public and EPA's responses are included in the Responsiveness Summary, which is part of this ROD.

11.0 SELECTED REMEDY

Following review and consideration of the information in the Administrative Record, including public comments, and the requirements of CERCLA and the NCP, EPA has selected the following as the remedy for Avtex Fibers Superfund Site OU 7: Alternative C –Basin Capping, Groundwater Extraction and Leachate Removal.

11.1 Summary of the Rationale for the Selected Remedy

EPA's selected alternative must meet the threshold criteria of overall protection of human health and the environment and compliance with ARARs. Based on the information currently available, EPA (the lead agency) has determined that Alternative C provides the best balance of the nine selection criteria.

EPA's selected alternative for OU7:

1) will be protective of human health and the environment;
2) will meet ARARs;
3) can be easily implemented in a relatively short timeframe; and
4) will provide long-term effectiveness and permanence.

Overall, EPA's selected alternative satisfies the statutory requirements of CERCLA §121 and the NCP by being protective of human health and the environment; complying with ARARs; being cost effective; and utilizing permanent solutions to the maximum extent practicable. The extraction and treatment of leachate and groundwater satisfies the preference for treatment as a principal element. The selected remedy is the best balance of the nine evaluation criteria.

11.2 Description of the Selected Remedy and Performance Standards

Based on consideration of the CERCLA requirements and analysis of alternatives using the nine criteria, EPA Region III has selected Alternative C - Basin Capping, Groundwater Extraction and Leachate Removal as the remedy for OU7 of the Avtex Fibers Superfund Site. Alternative C is protective, complies with ARARs, and satisfies all of the Remedial Objectives at a lower cost than Alternatives D or E.

This alternative consists of the extraction and treatment of leachate with the installation of a low permeable cap over Viscose Basins 9, 10, and 11 to reduce seepage of contaminants to overburden groundwater and the bedrock aquifer. The total present worth cost of EPA's selected remedy ranges from \$30,000,000 to \$31,400,000. The major components of the Selected Remedy are:

- Installation of a low permeability cap over Viscose Basins 9, 10, and 11.
- Construction and operation of a groundwater extraction and treatment system to meet both the risk-based and ARAR based in-situ groundwater cleanup standards.
- Construction and operation of a wastewater treatment plant.
- Evaluation of the basins and extraction and treatment of the leachate to meet performance standards.
- Characterization, removal, and disposal of impacted sediments associated with seeps adjacent to Viscose Basins 9, 10, and 11 and OU7 soils located outside of Viscose Basins 9, 10, and 11.
- Implementation of Institutional Controls.
- Provision of water to impacted property owners on west side of the South Fork Shenandoah River.
- Post-closure monitoring and maintenance.

Annual sampling of surface water, sediments and biota in the South Fork Shenandoah River will be conducted to determine if there are decreasing trends in the concentration of contaminants. Surface water sampling of the drainage way north of Viscose Basins 9 and 10 after construction of the cap will also be conducted.

11.2.1 Performance Standards for Leachate Evaluation, Extraction and Treatment

Based on existing knowledge of the viscose basins, standard vertical wells, supplemented with sumps, will be the most effective means to extract leachate. However, leachate pumping tests conducted during the FS demonstrated that the leachate may be caught in voids and fractures within the viscose and, therefore, it may be difficult to determine the locations for wells and sumps that can effectively extract leachate. Therefore, a pre-design investigation will include consideration of remote sensing technologies that might be effective in identifying the locations of voids and fractures. The use of standard vertical wells and sumps will be reconsidered during the pre-design investigation if EPA determines that the new data indicate a different approach would be more effective. The criteria and performance standards for the pre-design investigation and leachate extraction process are described in detail in Appendix B.

11.2.2 Air Monitoring Requirements

An air sampling and monitoring program will be implemented during the remedial action to ensure that air emissions: 1) do not result in air concentrations that pose an unacceptable risk by exceeding the 1×10^{-5} risk level for carcinogens or an HQ of 1 for non-carcinogens; 2) do not pose an ignition or explosion hazard; and 3) do not pose nuisance odor issues with off-site residents or users of the area. Additionally, following completion of construction of the remedial action, air sampling will be conducted in accordance with the sampling program and the analytical results will be incorporated into an air model to demonstrate that the air emissions do not exceed an excess cancer risk of 1×10^{-5} and that the target organ HI is less than or equal to 1 for non-carcinogens. Air sampling will be conducted annually until the results demonstrate to EPA's satisfaction that the performance standards are being met and there is a downward trend in air emission concentrations.

11.2.3 Soil Cleanup Performance Standards

OU-7 soils located outside the basins that are not to be covered by the Viscose Basins 9, 10, and 11 cover systems will be characterized. All soils and sediments classified as a hazardous waste within the meaning of 9VAC 20-60-261 will be disposed of appropriately at an off-site RCRA Subtitle C landfill. All soils and sediments that are not hazardous and do not exceed the groundwater protection standards but have concentrations that exceed the Regional Screening Levels for industrial soils at a total excess cancer risk of 1×10^{-5}, a total non-cancer risk for target organ-specific HQ of 1, and/or EPA's Region 3 Ecologically Protective Backfill Values, listed on Table 11, will be excavated and placed into the basins under the cap. Soils exceeding groundwater protection standards, but not classified as hazardous waste within the meaning of 9VAC be excavated and placed into the basins under the cap. Soils exceeding groundwater protection standards, but not classified as hazardous waste within the meaning of 9VAC 20-60-261, will be disposed off-site in an off-site RCRA Subtitle D landfill. The groundwater protection standard for a specific contaminant will be determined by dividing the Synthetic Precipitation Leaching Procedure ("SPLP") concentration by a Dilution Attenuation Factor ("DAF") of 10. This value will then be compared to the MCLGs if the MCLG is not zero. In the absence of a non-zero MCLG, the MCL is the groundwater protection standard. If neither a non-zero MCLG nor an MCL have been established for a compound, the groundwater protection standard is the Regional Screening Level for the ingestion of tapwater at a total excess cancer risk of 1×10^{-5}, and a total non-cancer risk for a target organ-specific HQ of 1 in place at the time the sample is collected. Confirmatory sampling of the excavated areas will be performed.

11.2.4 Provision of Water

EPA's selected remedy includes the provision of water to property owners on the west side of the South Fork Shenandoah River for which groundwater could potentially be impacted unacceptably by the contaminated groundwater plume. Currently there is one property owner receiving water who is over 1,000 feet north of the furthest edge of the known contaminated plume. It is unlikely that a private well at this location would draw Site-related contaminated groundwater. EPA will not require the provision of water to this property pursuant to this OU7 remedial action unless it determines that it has the potential to be impacted at a level that exceeds the selected cleanup standards.

11.2.5 Groundwater Extraction and Treatment Performance Standards

A groundwater extraction and treatment system will be constructed to prevent further migration of the plume. Groundwater will be treated until: (1) the cumulative excess lifetime cancer risk is less than one in ten thousand (1×10^{-4}); (2) non-cancer risks are reduced to a hazard index ("HI") of 1 (or less) for each specific organ; and (3) Maximum Contaminant Levels ("MCLs") for carcinogens and non-zero Maximum Contaminant Level Goals ("MCLGs") for non-carcinogens are not exceeded.

Historical and on-going releases of leachates from Viscose Basins 9, 10, and 11 have resulted in a contaminated groundwater plume in the fractured bedrock aquifer underlying the Site. Treatment will continue until the groundwater is restored to the remedial cleanup standards listed in Table 7. The remediation of groundwater at the Site will continue until the respective MCLs for carcinogens and MCLGs for non-carcinogens for the COCs are attained and the excessive cancer risk associated with potential residential use of the groundwater is reduced to one in ten thousand (1.0E-04) and the HI is reduced to 1. Because groundwater which meets the MCLs/MCLGs for individual contaminants may not meet the risk-based standards (1.0E-04 and HI less than or equal to 1) cumulatively if multiple contaminants are present, determination of meeting the "protection of human health and the environment" RAO will be performance-based.

When preliminary cleanup standards have been attained (Table 7), EPA will evaluate post- ROD data from the periodic groundwater monitoring and develop a trend analysis and risk assessment. The risk assessment will be based on an assessment of the cumulative risk across all applicable exposure routes for all COCs remaining in groundwater following achievement of the preliminary cleanup standards (i.e., MCLs for carcinogens and MCLGs for noncarcinogens). The remediation of groundwater at the Site will continue until the risk-based cleanup standards (1.0E-04 and HI less than or equal to 1) are achieved.

A wastewater treatment plant will be constructed to treat contaminated groundwater and leachate to meet the applicable and/or relevant and appropriate effluent discharge limits to the South Fork Shenandoah River. Off-gas emissions will be captured and treated, if necessary, to meet Virginia Regulations for the Control and Abatement of Air Pollution.

11.2.6 Installation of a Groundwater Extraction Well on West Side of South Fork Shenandoah River

If capture zone analyses demonstrates that the extraction system is not capturing the contaminated groundwater on the west side of the South Fork Shenandoah River, a groundwater extraction well will be installed on the west side of the South Fork Shenandoah River and incorporated into the treatment system.

11.2.7 Groundwater Monitori ng

A groundwater monitoring plan will be developed as a component of the remedial design to establish baseline conditions and to evaluate remedy performance following implementation of the remedial action. One or more additional wells may need to be installed to establish baseline conditions and/or evaluate the remedial action. Key components of the monitoring will include:

- Groundwater elevation monitoring will be completed to establish groundwater flow conditions and to support the capture zone analyses.
- Groundwater quality monitoring will be completed to evaluate remedy performance and to support plume capture zone analyses.

An initial evaluation of the effectiveness of the groundwater extraction system will be performed as soon as trouble shooting of operating procedures has been completed and the extraction system has stabilized, but no later than 1 year after system startup. This evaluation will evaluate whether the system design appears to be adequate to achieve the performance standards based on the information available at the time. Thereafter, a comprehensive evaluation of the system's effectiveness will be performed on an annual basis for the first 5 years after system startup; after 5 years, EPA will consider if the frequency of the evaluations should be changed or remain the same. As part of these evaluations, a detailed capture zone analysis will be completed and will serve as the basis for the assessment of whether the contingency extraction wells located in Rivermont Acres, north of Viscose Basins 9, 10, and 11, or elsewhere are required and/or if other modifications (e.g., placement of additional wells, increase/ decrease of groundwater extraction rates) are required. The information will also be used to determine if the remedy performance is acceptable and if the plume is being captured.

The groundwater monitoring plan shall be updated every five years, coinciding with EPA's five-year reviews, unless EPA develops an alternate schedule.

11.2.8 Surface Water Monitoring

The Virginia Department of Health currently has fish consumption advisories and restrictions due to PCBs for the South Fork Shenandoah River downstream from the Route 619 bridge crossing near Front Royal to the confluence with North Fork Shenandoah River, for the North Fork Shenandoah River from the mouth of the river upstream to Riverton Dam, and for the Shenandoah River from the confluence of the North and South Forks to the Virginia/West Virginia state line.

A surface water and sediment sampling plan for annual monitoring of the South Fork Shenandoah River will be developed. The plan shall evaluate surface water and sediment quality at locations upstream, adjacent to, and downstream of the Site. The plan shall include a biological component for monitoring invertebrate and fish for PCBs and other compounds. Threshold levels determined by EPA to be protective of ecological receptors shall be developed for inclusion in the long term monitoring plan and will be used to determine if concentrations detected in water and sediment attributed to the Site have reached acceptable levels.

In addition, the sampling plan will provide for sampling of the drainage way north of Viscose Basins 9 and 10 after construction of the cap under typical lower flow conditions as well as storm water sampling. This sampling will be conducted downgradient of the viscose basins.

11.2.9 Performance Standards for Viscose Basins 9, 10, and 11 Cap

A basin cap and cover will be designed and constructed to meet the VSWMR requirements of a hydraulic conductivity less than or equal to that of any natural subsurface soils present, or a hydraulic conductivity no greater than 10^{-5} cm/s, whichever is less. The cap will be designed to minimize infiltration of precipitation to the viscose materials. For cost estimating purposes, the FS included a conceptual design which is described below. The actual design and construction of the low-permeability cap will be determined during the remedial design. The conceptual design for the low-permeability cap includes the following components:

A geotextile liner will be placed over the basins prior to cap installation.

A bridging layer, consisting of 3 to 5 feet of clean soil/gravel, will be installed over the geotextile liner prior to cap construction.

A leachate drainage layer will be installed above the bridging layer. The leachate from this layer will be collected and treated in the wastewater treatment plant. The need for a subsurface leachate collection system in addition to this drainage layer will be evaluated during the remedial design phase.

A gas vent layer will be installed for either active gas collection and treatment or passive venting to the atmosphere. The need for active gas collection and treatment will be assessed during the remedial design phase based on a conservative quantification of gas generation rates and comparison of potential emissions from a passive venting system to ARARs.

A low permeability layer (infiltration layer) that achieves a maximum hydraulic conductivity of 8.2×10^{-8} cm/sec, which is the estimated permeability of the underlying soils, will be installed.

A surface drainage layer will be placed over the low permeability layer to capture water infiltrating through the overlying clean cover soil.

A minimum of 2 feet of clean cover soil suitable for revegetation and constructed to promote drainage by grading the top of the cover to a minimum of a 2 percent slope will be installed over the surface drainage layer and revegetated with native warm season grasses.

The OU7 design shall include, at a minimum, the following design elements: Design Criteria Report, Design Investigation Report, Design Basis, Remedial Design, Design Specifications, Design Calculations, Design Drawings, a Storm Water, Soil Erosion and Sediment Control Plan, a Construction Quality Assurance Plan, a Remedial Action Decontamination Plan, a Remedial Action Waste Management Plan, a Remedial Action Sampling and Analysis Plan that includes a Quality Assurance Project Plan, a Remedial Action Health and Safety Plan, an Operations and Maintenance Plan, a Groundwater Monitoring Plan, an Air Monitoring Plan, and a Surface Water/Sediment and Post-Closure Storm Water Monitoring, Institutional Control Implementation and Assurance Plan, Contingency Plans, and a Remedial Action Schedule.

Post-closure activities will be performed, including, but not limited to:

- Inspections and maintenance of the constructed remedy to maintain the integrity and effectiveness of the final cover system;
- Groundwater monitoring and reporting in accordance with monitoring requirements for industrial landfills set forth in 9VAC20-80-270D shall be performed (in addition to groundwater monitoring for other components of the OU7 remedy in accordance with any other ARARs);

- Maintaining and operating the leachate collection system; and
- Monitoring and maintaining the gas collection and monitoring system.

11.2.10 Land and Groundwater Use Restrictions for the Site and Surrounding Area

An Institutional Control Implementation and Assurance Plan ("ICIAP") shall be developed during the remedial design to address institutional controls ("ICs"), including land and groundwater use restrictions, for the Site. The requirements for institutional controls contained in this ROD are based on current, reasonably anticipated uses of the Site and areas in the vicinity of the Site. The purpose of the institutional controls shall be to prevent exposure to unacceptable risks associated with the groundwater and leachate during and after the remedy has been implemented and to protect the components of the selected remedy. The required ICs may include property use controls (such as easements and restrictive covenants) and governmental controls (such as zoning ordinances and local permits). The ICIAP shall identify parties responsible (i.e., Federal, State, or local authorities or private entities) for implementation, enforcement, and monitoring and long-term assurance of each IC, including costs, both short-term and long-term, and methods to fund the cost and responsibilities for each step. The ICIAP shall include maps, which shall describe coordinates of the restricted areas depicting all areas that do not allow unlimited use/unrestricted exposure and areas where ICs have been implemented along with a schedule for implementation of the remaining ICs. The maps and information about the ICs shall be made available to the public when approved by EPA. In addition, the ICIAP shall identify reporting requirements associated with each IC which shall include at a minimum an annual review of the status and effectiveness of the ICs and whether each IC is still appropriate.

Performance Standards for Land and Groundwater Use Restrictions for the Site and Surrounding Area

1. Maintain and protect the integrity of the engineered remedy, including, but not limited to, the Viscose Basins 9, 10, and 11 caps and storm water management features, monitoring wells, extraction wells, and WWTP. The ICs regarding wells will be removed when the wells are permanently removed.

2. Prevent the installation of drinking water supply wells in the area where the groundwater contamination levels exceed MCLs for carcinogens and MCLGs for non-carcinogens or risk-based concentrations, thus minimizing the potential for exposure to contaminated groundwater during the cleanup process. When cleanup standards listed on Table 7 have been met, the ICs to prohibit groundwater use will be removed.

11.3 Summary of Estimated Remedy Costs

The estimated capital cost of the remedy is $15,100,000 with an annual Operation and Maintenance[2] cost of $1,210,000 and a Present Worth Cost of $30,300,000. If an extraction well on the west side of the South Fork Shenandoah River is required, the estimated capital cost is $16,000,000 with an annual O&M cost of $1,230,000 and a Present Worth Cost of $31,400,000.

The information in the cost estimate is based on the best available information regarding the anticipated scope of the selected remedial action. Changes in the cost estimate are likely to occur as a result of new information and data collected during the engineering design of the selected remedy. Minor changes may be documented in the form of a memorandum. Changes that are significant, but not fundamental, may be documented in an Explanation of Significant Differences. Any fundamental changes would be documented in a ROD amendment.

11.4 Expected Outcome of the Selected Remedy

This section presents the expected outcomes of the selected remedy in terms of resulting land and groundwater uses and risk reduction achieved as a result of the response actions. The completion and maintenance of the Viscose Basins 9, 10, and 11 cover systems will eliminate the potential risk of exposure to contaminated material in the basins.

The groundwater remedy to be put in place at the Site is designed to remediate the groundwater. The groundwater remedy will continue until the groundwater cleanup standards are met.

The selected remedy will restrict any use of the basin area in ways that could interfere with any of the engineered components of the cover system. Groundwater use restrictions will prevent exposure to contaminated groundwater. Land use restrictions in the area of groundwater contamination will include restrictions to protect the groundwater wells and extraction wells. After the cleanup standards listed in Table 7 have been met for groundwater, the ICs to prohibit groundwater use will be removed.

12.0 STATUTORY DETERMINATIONS

Under Section 121 of CERCLA, 42 U.S.C. § 9621, selected remedies must protect human health and the environment, comply with ARARs (or waive them), be cost-effective and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Additionally, CERCLA includes a preference for remedies that use treatment to significantly and permanently reduce the volume, toxicity or mobility of hazardous wastes as their principal element. The

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[2] Because different components of the remedy have different periods of operation, annual O&M costs are calculated by annualizing the Net Present Value of the O&M costs over 30 years at a 7% discount.

following sections discuss how the selected remedy for OU7 of the Avtex Fibers Superfund Site meets these statutory requirements.

12.1 Protection of Human Health and the Environment

The selected remedy will protect human health and the environment by eliminating or mitigating exposure or the potential for exposure to Site-related contaminants through the remediation of the groundwater contamination and the installation of basin caps. The groundwater remedy will remediate the groundwater to cleanup standards.

12.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedy will attain all ARARs, some of which are identified as a performance standard in Section 11.2 and all of which are listed in Appendix A of this ROD.

12.3 Cost Effectiveness

The selected remedy is cost effective in that: (1) it eliminates or mitigates the risks posed by the contaminants at the Site; (2) it meets all requirements of CERCLA and the NCP; and (3) its overall effectiveness in meeting the remedial action objectives is proportional to its cost. Alternative C is the lowest cost alternative that is protective, meets State and Federal ARARs and treats a principal threat waste. It uses established technology and ranks high in short-term effectiveness when compared to the other alternatives.

12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected remedy utilizes long-term solutions and treatment technologies to the maximum extent practicable by pumping and treating the groundwater and extracting leachate from the basins. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the remedy provides the best balance of advantages and disadvantages, in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost, while also considering the statutory preference for treatment as a principal element, and State and community acceptance.

12.5 Preference for Treatment as a Principal Element

The selected remedy will meet the statutory preference for treatment as a principal element, since it treats contaminated leachate and groundwater present at the Site.

12.6 Five-Year Review Requirements

Because the OU7 remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted every five years to ensure that the remedy is, or will be, protective of human health and the environment pursuant to CERCLA Section 121 (c) and 40 C.F.R. § 300.430(f)(5)(iii)(C). The first five year review was triggered by the date that onsite construction began for OU2 and OU3. The fourth five-year review for this Site is scheduled for March 2013.

13.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The public comments did not result in any significant or fundamental changes in the selected remedy from the remedy proposed in the Proposed Plan.

III. RESPONSIVENESS SUMMARY

AVTEX FIBERS SUPERFUND SITE

OPERABLE UNIT 7

FRONT ROYAL, WARREN COUNTY, VIRGINIA

Avtex Fibers Superfund Site
Operable Unit 7
Front Royal, Warren County, Virginia

RESPONSIVENESS SUMMARY

This Responsiveness Summary documents public participation in the remedy selection process for Operable Unit 7 (OU7) at the Avtex Fibers Superfund Site. It contains a summary of the significant comments received by EPA on the Proposed Plan for Operable Unit 7 and EPA's responses to those comments.

A. Summary of Significant Comments from the Public Meeting on September 22, 2009 and EPA's Responses

EPA held a meeting on September 22, 2009 to accept public comments on EPA's Proposed Plan for Avtex Fibers Superfund Site Operable Unit 7. The significant comments received regarding the plan for OU7 are summarized here, along with EPA's responses to these comments. The entire transcript of the meeting, including all comments received and EPA's responses, is included in the publicly available portion of the Administrative Record for anyone who wants to view them.

1. **Comment:** Will groundwater contamination going into the river contaminate drinking water wells?

Response to comment: No. Sampling conducted during the Remedial Investigation did not indicate any measurable effects on the water quality of the South Fork Shenandoah River. The remedy will include annual monitoring of the South Fork Shenandoah River to allow continued evaluation of water quality in the river while groundwater is being remediated.

2. **Comment:** Will the pump and treat system impact residential wells on the western side of the South Fork Shenandoah River? How many gallons a day will the system pump?

Response to comment: The extent of the groundwater contamination is defined. The remedy includes implementation of institutional controls to prevent the installation of groundwater extraction wells within, and immediately adjacent to, the groundwater plume. Former wells located immediately west of the Shenandoah River were closed in the early 1980's because they were impacted by the groundwater plume. Water is provided to these property owners; they will continue to be provided water until the groundwater cleanup standards are met. There are residential wells, located further west of the river and situated topographically beyond and above the plume, referred to as Catlett Mountain residential wells. These Catlett Mountain residential wells are not impacted by the groundwater plume. The pump and treat system will be designed to capture the contaminated groundwater plume and is not expected to impact the Catlett Mountain residential wells.

The conceptual design for the system anticipates a groundwater pumping rate of 40 gallons per minute, which equals approximately 58,000 gallons per day.

3. When would the construction of the pump and treat system start? When will the pumping and treating of the groundwater begin?

EPA estimates that it will take two to three years to design and construct the groundwater treatment system.

4. **Comment:** How much contamination is in the groundwater?

Response to comment: The Feasibility Study estimated between 8.7 to 17.5 million gallons of leachate in Viscose Basins 9, 10 and 11. With respect to contamination in groundwater, the concentrations of contaminants in groundwater are known, the risks to human health have been assessed, and the impacts on the river have been evaluated. However, the volume of contaminated groundwater and the total amount (mass) of contaminants in the groundwater are not known because groundwater in the bedrock is dependent on the degree of fracturing and faulting at the Site, which is very complex. If estimates of the volume of contaminated groundwater or the total amount of contaminants in the groundwater were calculated, they would have such a wide range that they would be meaningless. Therefore, no estimates have been made.

5. **Comment:** What happens if there is a flood?

Response to comment: There have been floods at the Site in the past. Viscose Basins 9, 10, and 11 are outside the 100-year flood plain and, therefore, the surface of the basins would remain above the flood waters of such a flood. In respect to groundwater, the flood waters would act as a flushing event and could temporarily increase contaminant loading to the river, which could be offset by the dilution of the excess water in the river. The reaction below the ground surface during a flood event is similar to placing a soapy sponge into a bucket of water. Without squeezing the sponge, some of the soap will be released to the water, but most of the soap will remain in the sponge.

6. **Comment:** How long will the pump and treat system continue and when will it stop?

Response to comment: For cost estimating purposes, we calculated thirty years of pumping and treating groundwater. The actual time that will be required cannot be determined due to the nature of the fractured bedrock aquifer at the Site. It could take less time or it could take longer. Treatment of the groundwater will stop when the cleanup levels are achieved.

7. **Comment:** What type of groundwater monitoring will be conducted and will the public have access to this information?

Response to comment: A groundwater monitoring plan will be developed as a component of the remedial design. At a minimum, annual sampling will be conducted at selected monitoring wells to evaluate the effectiveness of the groundwater extraction system. Currently there are no residential wells within the plume or adjacent to the plume that would require monitoring. The public will have access to all of the groundwater data after the data have gone through the data validation process.

8. **Comment:** How is water provided to current and future users who may be impacted by the plume?

Response to comment: Currently FMC provides water via a truck to residences impacted by the groundwater plume. The same procedure would apply to any future residences that would be impacted by the groundwater plume.

9. **Comment:** Are there any alternatives that would remove all the waste, so you could just walk away and never look back?

Response to comment: The Feasibility Study explored over 100 different technologies for cleaning up the viscose basins and groundwater. Due to the hydrogeological conditions, the variability of the material in the viscose basins, and the reactivity of carbon disulfide, the treatment possibilities are limited. The five remedial alternatives presented in the Proposed Plan were the best options for cleaning up the Site. Alternative E had the potential to come closest to removing the waste from the viscose basins but there was a large uncertainty as to whether the technology would work on such a reactive waste, in addition to being very expensive to implement and hazardous to Site workers.

10. **Comment:** Will Alternative C remove all the chemicals in the viscose basins and groundwater?

Response to comment: Although it will take decades, pump and treat systems have the potential to remediate groundwater to cleanup levels. The leachate in the viscose basins is located in voids in the basins which makes it more challenging to remove. It is EPA's goal to have as much leachate removed as possible, but we do not expect removal of all of the leachate.

11. **Comment:** Will there be any waste generated at the wastewater treatment plant, and where will it be disposed?

Response to comment: Sludge will be generated at the wastewater treatment plant and will be shipped off-site to an appropriate disposal facility.

12. **Comment:** What will be the extent of the monitoring, is it just the plume, or the entire Avtex Site?

Response to comment: The remedy for OU7 entails monitoring all elements of OU7, including the groundwater plume, surface water (e.g., the South Fork Shenandoah River), and Viscose Basins 9, 10, and 11. The groundwater monitoring program will be designed to define the boundaries of the plume, provide information for pump and treat system capture zone analysis, evaluate trends in contaminant concentrations, and meet other needs. The monitoring program for the South Fork Shenandoah River will include surface water monitoring, sediment monitoring, and ecological monitoring. Viscose Basins 9, 10, and 11 will also be monitored. The response actions for other operable units also contain active monitoring programs for other areas of the Site; for instance, there are monitoring requirements for the various disposal units under OU10 (Viscose Basins 1 through 8, and the New Landfill) and the Non-Time-Critical Removal Action – Basins (Fly Ash Basins, Sulfate Basins 1 through 5, and the wastewater treatment plant basins).

13. **Comment:** Will private wells be monitored?

Response to comment: The extent of groundwater contamination has been defined. Currently, no one is using private wells that are impacted by the groundwater contamination. The remedy includes a groundwater monitoring program to ensure that private wells are not impacted in the future. The monitoring program will utilize existing wells, and may include additional wells, to confirm that the pump and treat system is capturing the contaminated groundwater plume. At this time, EPA does not anticipate the monitoring of private wells. In the unlikely event that groundwater migrates toward private wells, these wells would be monitored.

14. **Comment:** What happens if you find carcinogens in a private residential well?

Response to Comment: If carcinogens are found in a private well we would notify the resident and the Department of Health of the sampling results. Depending on the contaminant and the concentration of the contaminant, EPA may recommend an alternative water supply or a treatment system.

15. **Comment:** Does EPA have any concerns that the pumping system for groundwater could draw groundwater from the unlined landfill up on the hill across from the Site?

Response to comment: The landfill is located to the north and west of the groundwater plume. The goal of the design is to capture the plume and at the same time minimize the amount of water requiring treatment. EPA does not anticipate that the extraction system will draw any groundwater from the unlined landfill. The design and implementation of the remedy will include a monitoring plan to define the extent of extraction and if a problem arises, EPA will address it.

16. **Comment:** Are the soccer fields safe? Is it safe to develop small businesses and a hotel on the Site?

Response to Comment: The soccer fields were developed because the soils met the cleanup standards for recreational use and are safe to use. The former processing plant area is still under remediation. This area will be remediated to industrial/commercial use cleanup standards. There is an easement which restricts the future use of this area. Any future development of this area would have to comply with this easement.

B. Written Comments from the Public

EPA received two letters containing comments on the Proposed Plan. The full text of the comments is included in the publicly available portion of the Administrative Record.

1. **Comment:** The description of the orange leachate should read, "The orange leachate is a dense aqueous phase liquid (DAPL)…"

Response to Comment: EPA agrees. The necessary changes are made in the Record of Decision.

2. **Comment:** Section 7.2.1 of the Proposed Plan discusses the components of the low permeability cap. The ROD should make it clear that this is a conceptual design for cost estimating purposes.

Response to comment: EPA agrees. Section 9.2.1 of the Record of Decision states that the components of the cap are conceptual and developed for cost-estimating purposes. The actual components and their specifications will be determined during the design phase.

3. **Comment:** Section 10 states that the low permeability cap would not be installed until after leachate extraction. The sequence of events will be determined during remedial design.

Response to comment: EPA agrees. Section 11.2 of the ROD is modified from the Proposed Plan to allow flexibility in the sequencing of events.

4. **Comment:** The Proposed Plan refers to "EPA's Region III Ecologically Protective Backfill Values" but does not include the values.

Response to comment: EPA agrees and a table is included in the ROD.

5. **Comment:** The Proposed Plan refers to a dilution attenuation factor ("DAF") of 5 for the groundwater protection soil cleanup standard. The Feasibility Study developed a DAF of 10 for the groundwater protection soil cleanup standard.

Response to comment: EPA agrees. This was a typographical error; the DAF should have been specified as 10. Section 11.2.3 of the ROD specifies a DAF of 10 for the groundwater protection soil cleanup standard.

6. **Comment:** The Proposed Plan recommended evaluation of a drainage way north of Viscose Basins 4, 5, and 6. This work is being addressed under Operable Unit 10 in a proposal submitted to EPA.

Response to comment: EPA agrees and has removed the evaluation of this drainage way from the ROD.

7. **Comment:** Items 3 and 4 in Appendix B should be reworded to better reflect that the scope of the successive step will be adjusted based on the findings of the proceeding step. Specifically, item 3 should state that the scope of the full scale remote sensing study will be refined based upon the results of the initial evaluation under item 1. In addition, item 4 should link to item 3 in that the locations of the CPT points are intended to target remote sensing anomalies.

Response to comment: Item 3 has been revised to incorporate the clarification recommended in the comment. As recommended by the comment, item 4 has been revised to clarify that, if a full scale remote sensing investigation is performed successfully, the CPT points will target anomalies identified by remote sensing. However, the number of CPT points will be dependent on the extent to which the remote sensing investigation clarifies the subsurface conditions in respect to the location of voids and/or leachate.

8. **Comment:** The ROD should include an action that fully funds the enforcement costs of holding the terms of the existing Conservation Easement on the former Avtex property

Response to comment: The existing Conservation Easement was entered into in November of 1999 and remains enforceable by its own terms, which do not require payment to any party. The ROD does require an Institutional Control Implementation and Assurance Plan that identifies parties responsible for implementation, enforcement, and monitoring and long-term assurance of each institutional control required by the ROD, including costs, both short-term and long-term, and methods to fund the costs and responsibilities for each step.

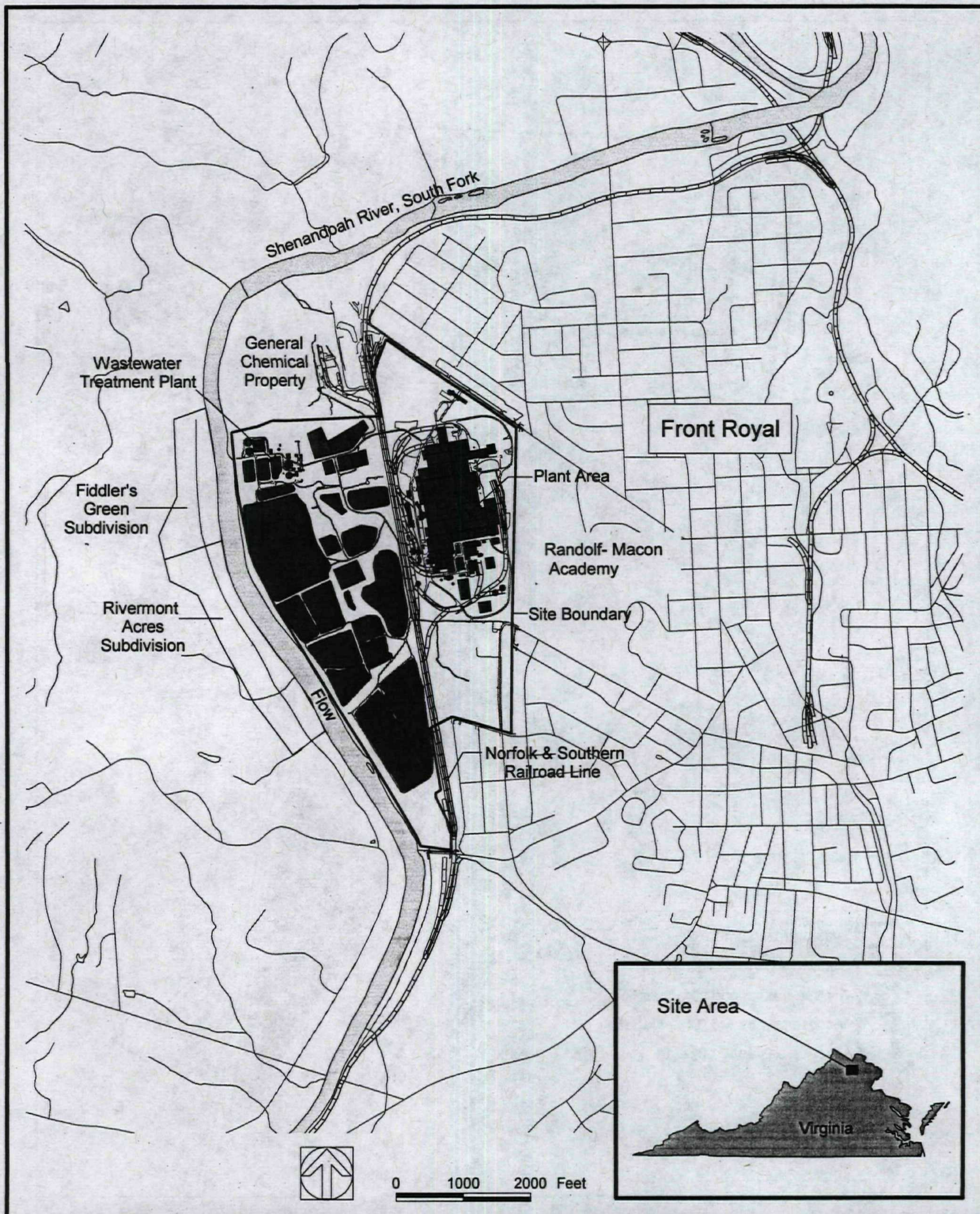

Figure 1 Avtex Location Map

\\192.168.3.11\projects\C045_Avtex\Working\Feasibility Study\EPA Comments\FS_CRD_11-05\Figures\Figure 1-1.doc

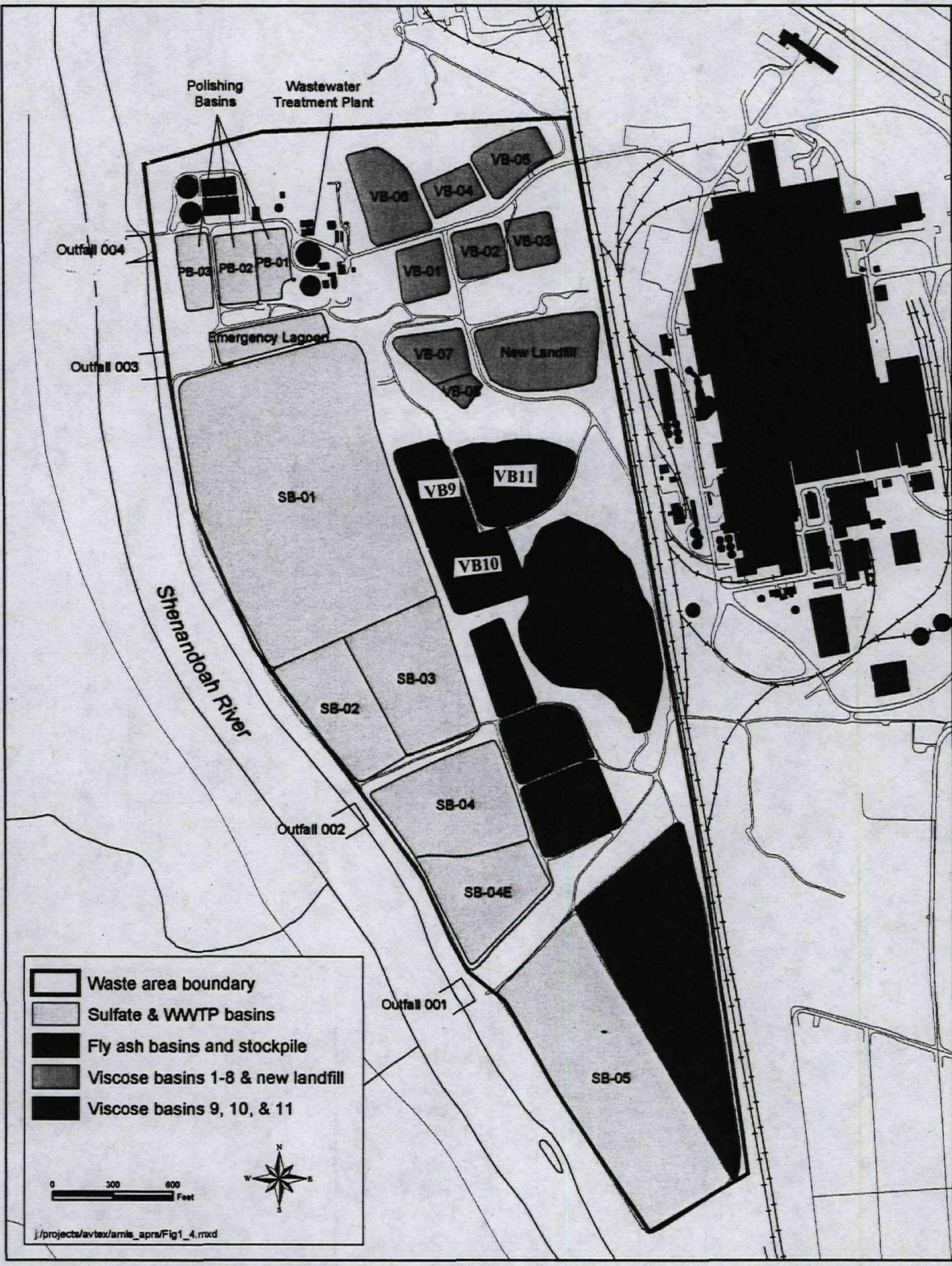

Figure 2 Avtex site waste disposal impoundments

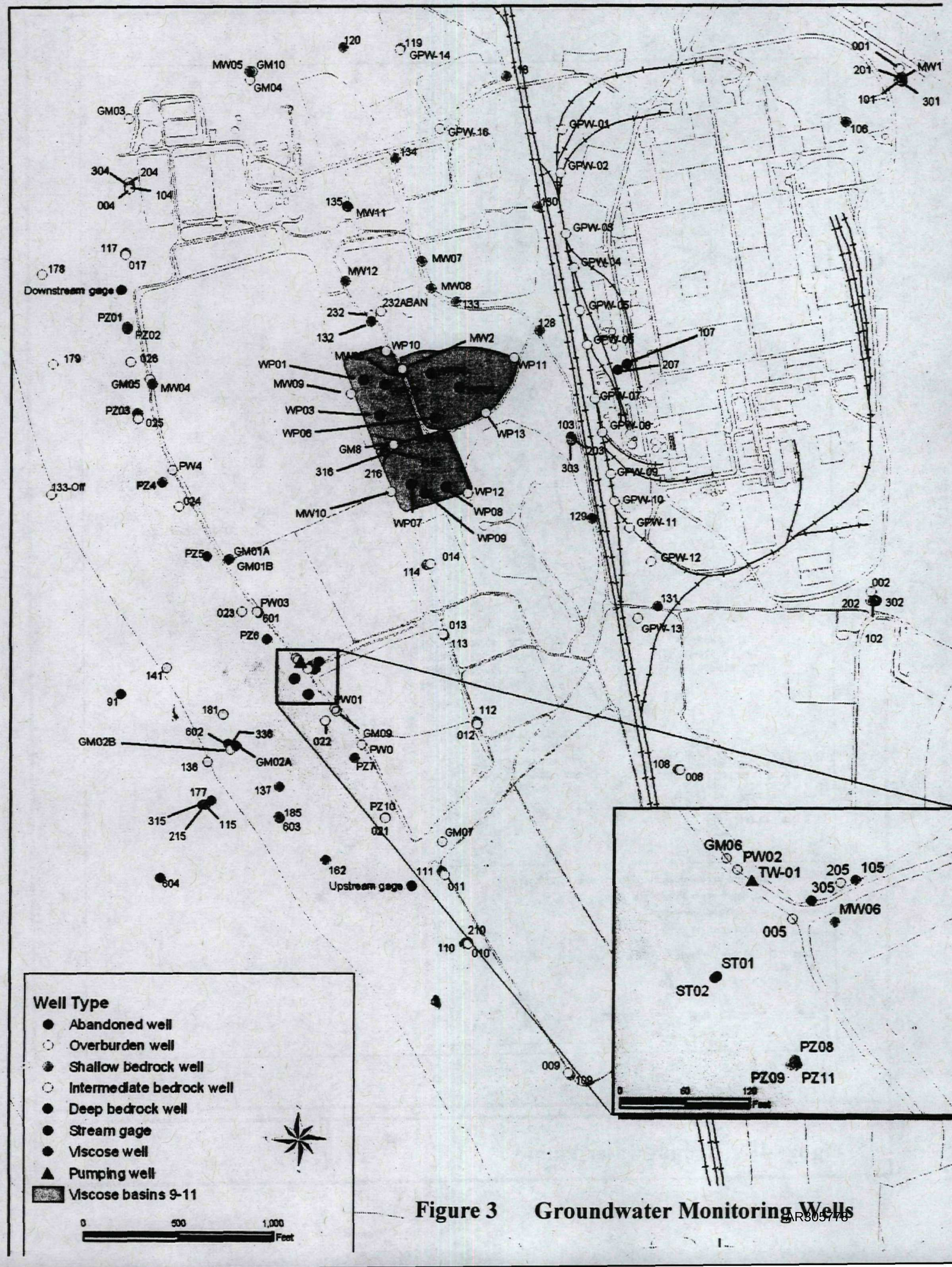

Figure 3 Groundwater Monitoring Wells

AR305778

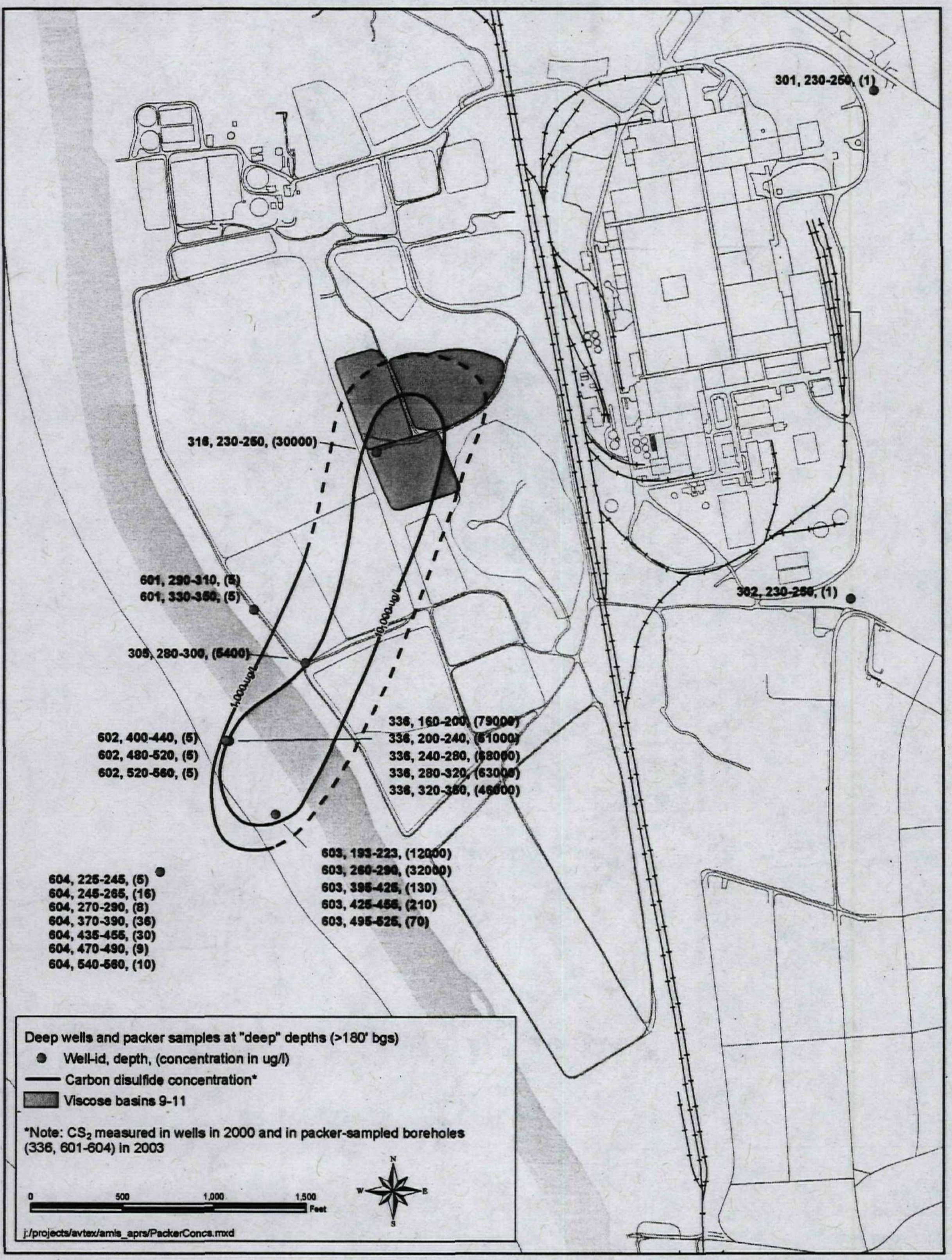

Figure 4 Groundwater Plume

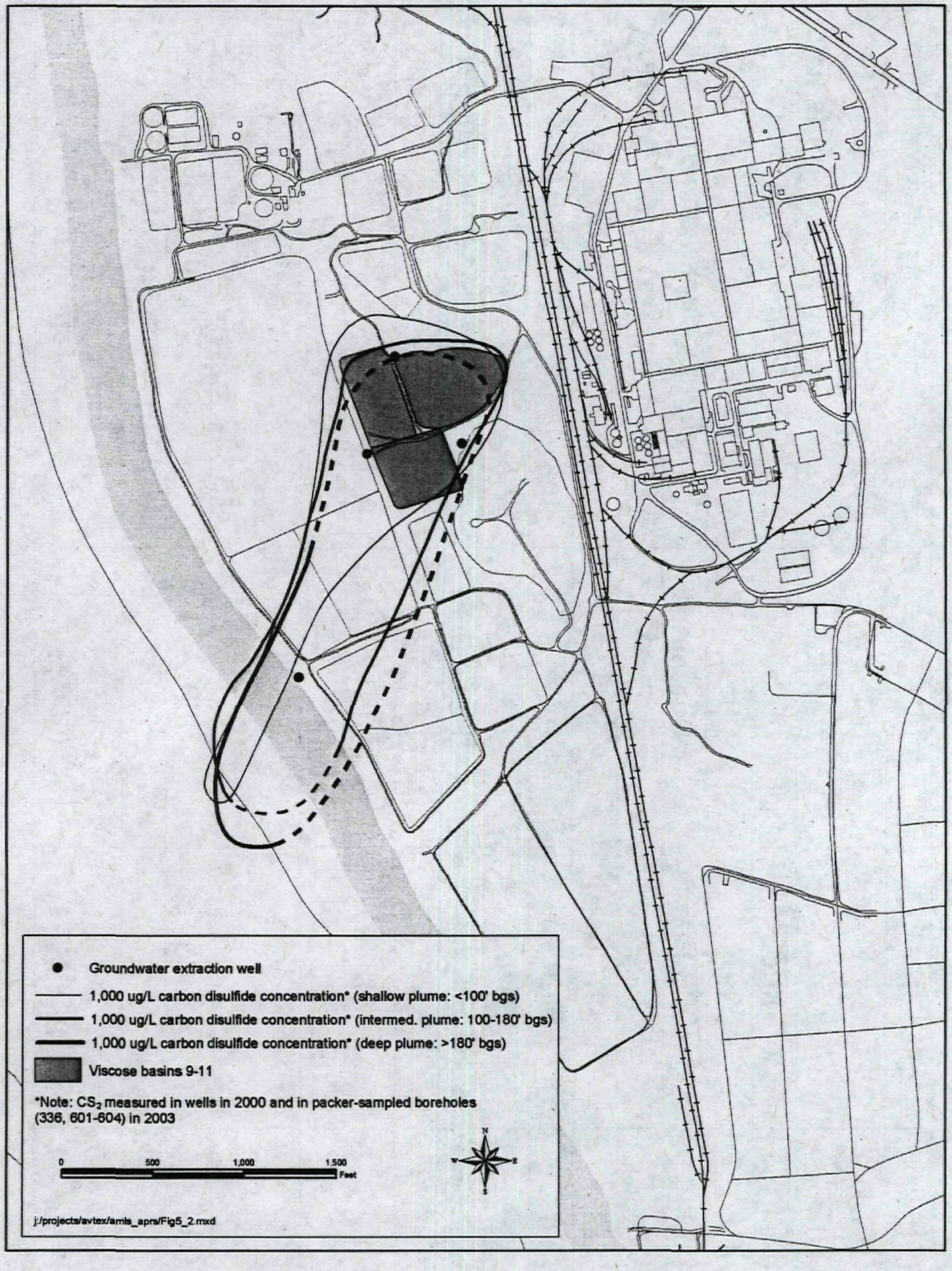

Figure 5 Conceptual layout of extraction wells

Table 2
Chemical Profile Viscose Basin 9-11 Leachate

Parameter	Green	Mixed	Orange
TCL Volatile Organics (ug/L)			
Carbon disulfide (CS_2)	5,000	3,000,000	8,000,000
TAL Metals (mg/L)			
Antimony (Total)	0.012	0.24	0.7
Arsenic	0.1	0.4	1.0
Calcium	50	35	4
Magnesium, Total	20	13	0
Zinc, Total	2	10	30
Silicon, Total	50	2,500	7,300
Sodium, Total	2,000	9,700	25,000
Water Quality (mg/L)			
Chemical Oxygen Demand	3,300	14,000	42,500
Sulfide	400	600	1,900
Total dissolved solids	7,000	32,000	83,000
Alkalinity, Total	4,000	7,500	20,000
pH	7.0	8 – 11.5	12.5 – 12.8
Density (g/ml)	1.0	1.00 – 1.06	1.06

Estimated 91% of CS_2 Mass is in the leachate; 9% is in the viscose solids

Table 3

Contaminants of Concern in Groundwater

Volatile Organics
Acetone
Carbon Disulfide

Semivolatile Organics
2-Methylphenol
4-Methylphenol
Bis(2-ethyhexyl)phthalate
Naphthalene
Pentachlorophenol
Phenol

Metals
Aluminum
Antimony
Arsenic
Cadmium
Chromium
Cobalt
Cyanide
Iron
Lead
Manganese
Mercury
Nickel
Vanadium
Zinc

Risk Summary - Adult Resident
Reasonable Maximum Exposure
Avtex Fibers Superfund Site, Front Royal, Virginia

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Constituent	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground water	Ground water	Tap Water	Aluminum	NA	NA	NA	0.0E+00	developmental nervous system	7.4E-02	—	1.3E-04	7.4E-02
			Ammonia	NA	NA	NA	0.0E+00	NA	NA	1.7E-02	NA	1.7E-02
			Antimony	NA	NA	NA	0.0E+00	blood	2.1E+01	—	2.5E-01	2.1E+01
			Arsenic	8.2E-03	NA	1.5E-05	8.2E-03	skin, vascular	5.3E+01	—	9.5E-02	5.3E+01
			Cadmium	NA	NA	NA	0.0E+00	kidney	1.6E-01	—	5.9E-03	1.7E-01
			Chromium, hexavalent	NA	NA	NA	0.0E+00	respiratory	1.6E+00	—	2.4E-01	1.9E+00
			Cobalt	NA	NA	NA	0.0E+00	blood, skin, respiratory	5.2E-01	—	3.8E-04	5.2E-01
			Cyanide	NA	NA	NA	0.0E+00	thyroid, myelin (CNS)	3.6E-01	—	6.4E-04	3.6E-01
			Iron	NA	NA	NA	0.0E+00	blood, liver, GI tract	2.1E-01	—	3.8E-04	2.1E-01
			Lead	NA	NA	NA	0.0E+00	NA	NA	—	NA	0.0E+00
			Manganese	NA	NA	NA	0.0E+00	CNS	1.9E+00	—	8.5E-02	2.0E+00
			Mercury	NA	NA	NA	0.0E+00	CNS	7.8E+00	1.1E+02	1.4E-02	1.1E+02
			Nickel	NA	NA	NA	0.0E+00	kidney, liver, spleen	9.9E-01	—	8.9E-03	1.0E+00
			Vanadium	NA	NA	NA	0.0E+00	kidney	7.8E+00	—	5.4E-01	8.4E+00
			Zinc	NA	NA	NA	0.0E+00	blood	3.7E-01	—	4.0E-04	3.7E-01
			2-Methylphenol	NA	NA	NA	0.0E+00	whole body (decreased weight), CNS	2.0E-01	—	1.1E-02	2.1E-01
			4-Methylphenol	NA	NA	NA	0.0E+00	CNS, respiratory, whole body (maternal death)	4.2E-01	—	2.3E-02	4.5E-01
			bis(2-Ethylhexyl)phthalate	1.6E-06	NA	1.4E-06	2.9E-06	liver	1.6E-02	—	1.4E-02	3.1E-02
			Naphthalene	NA	NA	NA	0.0E+00	whole body (decreased weight), kidney, thymus, respiratory tract	8.9E-02	2.0E+00	3.4E-02	2.1E+00
			Pentachlorophenol	6.8E-06	NA	4.6E-05	5.3E-05	liver, kidney	5.5E-03	—	3.7E-02	4.3E-02
			Phenol	NA	NA	NA	0.0E+00	whole body, fetus	1.4E+00	—	4.0E-02	1.5E+00
			Acetone	NA	NA	NA	0.0E+00	kidney	3.4E-02	—	9.4E-05	3.4E-02
			Carbon disulfide	NA	NA	NA	0.0E+00	fetus, peripheral nervous system	4.2E+01	3.6E+01	4.3E+00	8.2E+01
			Chemical Total	8.2E-03	0.0E+00	6.2E-05	8.2E-03		1.4E+02	1.4E+02	5.7E+00	2.9E+02
		Exposure Point Total					8.2E-03					2.9E+02
	Total						8.2E-03					2.9E+02
						Total Risk Across All Media	8.2E-03				Total Hazard Across All Media	2.9E+02

Total Nervous System HI Across All Media =	2.0E+02
Total Kidney HI Across All Media =	1.2E+01
Total Blood HI Across All Media =	2.2E+01

NA = Not Applicable

Table 4 Risk Summary for Adult Resident

AR305783

Risk Summary - Child Resident
Reasonable Maximum Exposure
Avtex Fibers Superfund Site, Front Royal, Virginia

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age: Child	

Medium	Exposure Medium	Exposure Point	Constituent	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground water	Ground water	Tap Water	Aluminum	NA	NA	NA	0.0E+00	developmental nervous system	1.7E-01	—	3.8E-04	1.7E-01
			Ammonia	NA	NA	NA	0.0E+00	NA	NA	7.9E-03	NA	7.9E-03
			Antimony	NA	NA	NA	0.0E+00	blood	4.8E+01	—	7.0E-01	4.9E+01
			Arsenic	4.8E-03	NA	1.0E-05	4.8E-03	skin, vascular	1.2E+02	—	2.7E-01	1.2E+02
			Cadmium	NA	NA	NA	0.0E+00	kidney	3.8E-01	—	1.7E-02	4.0E-01
			Chromium, hexavalent	NA	NA	NA	0.0E+00	respiratory	3.8E+00	—	6.7E-01	4.5E+00
			Cobalt	NA	NA	NA	0.0E+00	blood, skin, respiratory	1.2E+00	—	1.1E-03	1.2E+00
			Cyanide	NA	NA	NA	0.0E+00	thyroid, myelin (CNS)	8.3E-01	—	1.8E-03	8.3E-01
			Iron	NA	NA	NA	0.0E+00	blood, liver, GI tract	5.0E-01	—	1.1E-03	5.0E-01
			Lead	NA	NA	NA	0.0E+00	NA	NA	—	NA	0.0E+00
			Manganese	NA	NA	NA	0.0E+00	CNS	4.4E+00	—	2.4E-01	4.6E+00
			Mercury	NA	NA	NA	0.0E+00	CNS	1.8E+01	4.9E+01	3.9E-02	6.8E+01
			Nickel	NA	NA	NA	0.0E+00	kidney, liver, spleen	2.3E+00	—	2.5E-02	2.3E+00
			Vanadium	NA	NA	NA	0.0E+00	kidney	1.8E+01	—	1.5E+00	2.0E+01
			Zinc	NA	NA	NA	0.0E+00	blood	8.6E-01	—	1.1E-03	8.6E-01
			2-Methylphenol	NA	NA	NA	0.0E+00	whole body (decreased weight), CNS	4.5E-01	—	2.4E-02	4.8E-01
			4-Methylphenol	NA	NA	NA	0.0E+00	CNS, respiratory, whole body (maternal death)	9.8E-01	—	5.1E-02	1.0E+00
			bis(2-Ethylhexyl)phthalate	9.2E-07	NA	7.5E-07	1.7E-06	liver	3.8E-02	—	3.1E-02	7.0E-02
			Naphthalene	NA	NA	NA	0.0E+00	whole body (decreased weight), kidney, thymus, respiratory tract	2.1E-01	9.8E+00	7.4E-02	1.0E+01
			Pentachlorophenol	3.9E-06	NA	2.5E-05	2.9E-05	liver, kidney	1.3E-02	—	8.2E-02	9.5E-02
			Phenol	NA	NA	NA	0.0E+00	whole body, fetus	3.3E+00	—	8.9E-02	3.4E+00
			Acetone	NA	NA	NA	0.0E+00	kidney	8.0E-02	—	2.1E-04	8.0E-02
			Carbon disulfide	NA	NA	NA	0.0E+00	fetus, peripheral nervous system	9.8E+01	1.7E+01	9.4E+00	1.2E+02
			Chemical Total	4.8E-03	0.0E+00	3.6E-05	4.8E-03		3.3E+02	7.6E+01	1.3E+01	4.1E+02
		Exposure Point Total					4.8E-03					4.1E+02
	Total						4.8E-03					4.1E+02
						Total Risk Across All Media	4.8E-03				Total Hazard Across All Media	4.1E+02

Total Nervous System HI Across All Media =	2.0E+02
Total Kidney HI Across All Media =	3.3E+01
Total Blood HI Across All Media =	5.2E+01

NA = Not Applicable

Table 5 Risk Summary for Child Resident

Risk Summary - Child/Adult Residents
Reasonable Maximum Exposure
Avtex Fibers Superfund Site, Front Royal, Virginia

Scenario Timeframe: Future
Receptor Population: Lifetime Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Cancer Hazard Calculations				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ (s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground water	Ground water	Tap Water	Aluminum	NA	NA	NA	NA	—	—	—	—	—
			Ammonia	NA	NA	NA	NA	—	—	—	—	—
			Antimony	NA	NA	NA	NA	—	—	—	—	—
			Arsenic	1.3E-02	NA	2.5E-05	1.3E-02	—	—	—	—	—
			Cadmium	NA	NA	NA	NA	—	—	—	—	—
			Chromium, hexavalent	NA	NA	NA	NA	—	—	—	—	—
			Cobalt	NA	NA	NA	NA	—	—	—	—	—
			Cyanide	NA	NA	NA	NA	—	—	—	—	—
			Iron	NA	NA	NA	NA	—	—	—	—	—
			Lead	NA	NA	NA	NA	—	—	—	—	—
			Manganese	NA	NA	NA	NA	—	—	—	—	—
			Mercury	NA	NA	NA	NA	—	—	—	—	—
			Nickel	NA	NA	NA	NA	—	—	—	—	—
			Vanadium	NA	NA	NA	NA	—	—	—	—	—
			Zinc	NA	NA	NA	NA	—	—	—	—	—
			2-Methylphenol	NA	NA	NA	NA	—	—	—	—	—
			4-Methylphenol	NA	NA	NA	NA	—	—	—	—	—
			bis(2-Ethylhexyl)phthalate	2.5E-06	NA	2.1E-06	4.6E-06	—	—	—	—	—
			Naphthalene	NA	NA	NA	NA	—	—	—	—	—
			Pentachlorophenol	1.1E-05	NA	7.1E-05	8.2E-05	—	—	—	—	—
			Phenol	NA	NA	NA	NA	—	—	—	—	—
			Acetone	NA	NA	NA	NA	—	—	—	—	—
			Carbon disulfide	NA	NA	NA	NA	—	—	—	—	—
			Chemical Total				1.3E-02					--
		Exposure Point Total					1.3E-02					--
	Exposure Medium Total						1.3E-02					--
Ground Water Total							1.3E-02					--
						Total of Receptor Risks for Ground Water	1.3E-02				Total of Receptor Hazard for Ground Water	--

Note: Child/Adult cancer risk was calculated as the sum of the Child cancer risk (Table 8b RME) and the Adult cancer risk (Table 8a RME).

NA = Not Applicable

Table 6 Risk Summary for Adult/Child

Table 7

Groundwater Clean-up Standards (ug/L)[1]

	MCL/non-zero MCLG	Risk Based Concentration[2]
Volatile Organics		
Acetone		22,000
Carbon Disulfide		1,000
Semivolatile Organics		
2-Methylphenol (o-Cresol)		1,800
4-Methylphenol (p-Cresol)		180
bis(2-ethylhexyl)phthalate	6	
Naphthalene		14
Pentachlorophenol	1	
Phenol		11,000
Metals		
Aluminum		37,000
Antimony	6	
Arsenic	10	
Cadmium	5	
Chromium	100	
Cobalt		11
Cyanide, Free	200	
Iron		26,000
Lead	15	
Manganese		880
Mercury	2	
Nickel		730
Vanadium		260
Zinc		11,000

[1] The remediation of groundwater at the Site will continue until the respective MCls for the COCs are attained and the excessive cancer risk associated with potential residential use of the groundwater is reduced to one in ten thousand (1×10^{-4}) and the HI is reduced to 1 for each specific organ.
[2] EPA Region III risk-based tap water standards presented at cancer/hazard target benchmarks of 1×10^{-4} for carcinogens and 1 for noncarcinogens.

Table 8 Cost Summary

Alternative	Cost Component	Capital	Annual O&M[1]	Total Present Worth Cost
B. Basin Capping and Ground Water Extraction				
	Base Cost	$12,600,000	$930,000	$24,200,000
	Base Cost with Water Supply	$12,600,000	$950,000	$24,500,000
	Base Cost with Water Line Installation	$13,400,000	$930,000	$25,000,000
	Base Cost with Water Supply and Contingency Extraction Well	$13,500,000	$970,000	$25,600,000
C. Leachate Removal, Basin Capping, and Ground Water Extraction				
	Base Cost	$15,100,000	$1,190,000	$30,000,000
	Base Cost with Water Supply	$15,100,000	$1,210,000	$30,300,000
	Base Cost with Water Line Installation	$15,900,000	$1,190,000	$30,800,000
	Base Cost with Water Supply and Contingency Extraction Well	$16,000,000	$1,230,000	$31,400,000
D. In-situ Treatment and Ground Water Extraction				
	Base Cost	$62,000,000	$980,000	$74,200,000
	Base Cost with Water Supply	$62,000,000	$1,000,000	$74,500,000
	Base Cost with Water Line Installation	$62,800,000	$980,000	$75,000,000
	Base Cost with Water Supply and Contingency Extraction Well	$62,900,000	$1,020,000	$75,600,000
E. Ex-situ Treatment and Ground Water Extraction				
	Base Cost	$129,400,000	$1,060,000	$142,500,000
	Base Cost with Water Supply	$129,400,000	$1,080,000	$142,800,000
	Base Cost with Water Line Installation	$130,200,000	$1,060,000	$143,300,000
	Base Cost with Water Supply and Contingency Extraction Well	$130,300,000	$1,100,000	$143,900,000

[1] Because different components of the alternatives have different periods of operation, Annual O&M costs are calculated by annualizing the Net Present Value of the O&M costs over 30 years at a 7% discount.

	Protectiveness	ARARs	Long-term Effectiveness & Permanence	Short-term Effectiveness	Reduction in TMV	Implementability	Cost
Alternative A- No Action	Not Protective	Would not comply	Not effective or permanent	Not effective	No reduction	Easy	$0
Alternative B – P&T GW, Cap Viscose Basins	Does not achieve all RAOs	Would not comply	The cap prevents exposure but does not treat principal threat waste (leachates)	Minimal short term risks	P&T will reduce contamination in GW, but does not treat principal thereat	Easy because it relies on established technology	$24.5 M
Alternative C- P&T GW & Leachate, Cap Viscose Basins	Protective & achieves all RAOs	Could Comply	Could possibly leave some leachate, but the majority will be treated making this an effective and permanent remedy	Minimal short term risks	Would result in a substantial reduction in reducing TMV by treating the principal threat as well as GW	Relatively easy because it relies on established technology. Designing the treatment system presents some challenges.	$30.3 M
Alternative D – P&T GW, In-situ Treat VB Solids & Leachate w/ERH, Cap Viscose Basins	Protective & achieves all RAOs	Could Comply	Uncertainty if ERH will be effective in treating leachate and solids in Viscose Basin. If successful, would be permanent	Some short-term risk due to release of gases and odors during the heating process	Would result in a substantial reduction in reducing TMV by treating the principal threat as well as GW	Difficult because it relies on innovative technology that has not been demonstrated full scale on viscose waste.	$74.5 M
Alternative E – P&T GW & Leachate, Ex-situ Treat VB Solids and off-site disposal	Protective & achieves all RAOs	Could Comply	The most effective and permanent alternative.	Significant short term risk due to release of contaminants during excavation and additional truck traffic.	Would result in a substantial reduction in reducing TMV by treating the principal threat as well as GW	May be difficult due to the release of air emissions and odors, as well as the reactivity of the waste.	$143 M

Table 9 Comparison of Alternatives to Threshold and Balancing Criteria

Table 10 Comparison of Alternatives to Remedial Action Objectives

	Alternative B- P&T GW, Cap VB 9-11	Alternative C – P&T GW & Leachate, Cap VB 9-11	Alternative D- P&T GW, ERH (Insitu treatment of VB solids) & leachate, Cap VB 9-11	Alternative E – P&T GW, Exsitu treatment of VB Solids & remove some Leachate
RAO 1: Prevent human exposure (human ingestion, inhalation or dermal contact) to ground water that contains site related COCs that would result in unacceptable levels of risk	Provision of water eliminates the need to use ground water for domestic use. Institutional Controls would be implemented to prevent ground water use. These actions would be conducted until cleanup levels are achieved. Alternative B would achieve RAO 1.	Provision of water eliminates the need to use ground water for domestic use. Institutional Controls would be implemented to prevent ground water use. These actions would be conducted until cleanup levels are achieved. Alternative C would achieve RAO 1.	Provision of water eliminates the need to use ground water for domestic use. Institutional Controls would be implemented to prevent ground water use. These actions would be conducted until cleanup levels are achieved. Alternative D would achieve RAO 1.	Provision of water eliminates the need to use ground water for domestic use. Institutional Controls would be implemented to prevent ground water use. These actions would be conducted until cleanup levels are achieved. Alternative E would achieve RAO 1.
RAO 2: Prevent human and ecological receptor exposure through direct contact with waste in viscose basins 9, 10, and 11.	Placement of a cap on the viscose basins will prevent direct contact. Alternative B would achieve RAO 2.	Placement of a cap on the viscose basins will prevent direct contact. Alternative C would achieve RAO 2.	Placement of a cap on the viscose basins will prevent direct contact. Alternative D would achieve RAO 2.	Excavation of the viscose basins will eliminate direct contact. Alternative E would achieve RAO 2.
RAO 3: Mitigate the risks from the principal threat wastes in viscose basins 9, 10, and 11 by treatment of the leachate	This alternative will not extract and treat the concentrated leachate and therefore would not achieve RAO 3.	Extraction and treatment of the leachate would reduce the mass of contamination in the viscose basins. Alternative C would achieve RAO 3.	Although there is some uncertainty of the effectiveness of ERH, treatment of the leachate would reduce the mass of contamination in the viscose basins. Alternative D would achieve RAO 3.	Under Alternative E, the risks from the principal threat wastes in viscose basins 9, 10, and 11 would be eliminated by excavation of the viscose solids and extraction of any residual leachate. Alternative E would

Table 10 Comparison of Alternatives to Remedial Action Objectives

	Alternative B- P&T GW, Cap VB 9-11	Alternative C – P&T GW & Leachate, Cap VB 9-11	Alternative D- P&T GW, ERH (Insitu treatment of VB solids) & leachate, Cap VB 9-11	Alternative E – P&T GW, Exsitu treatment of VB Solids & remove some Leachate
				achieve RAO 3.
RAO4: Restore the ground water to its beneficial uses by reducing contaminant concentrations such that the cumulative excess lifetime cancer risk is less than one in ten thousand ($1X10^{-4}$); the target organ-specific hazard index (HI) is less than one, and MCLs and non-zero Maximum Contaminant Level Goals (MCLGs) are not exceeded.	Although the capping of the viscose basins will reduce the loading of contaminants into the groundwater, the concentrated leachate would remain in the basins. Therefore, it is unlikely that Alternative B would meet RAO 4.	Pumping and treating the groundwater, removing the principal threat (leachate in the viscose basins) with extraction and treatment, and capping the viscose basins to prevent further infiltration will result in improved groundwater quality. Although it is likely that Alternative C will restore the aquifer to drinking water standards, it will take a considerable amount of time.	Pumping and treating the groundwater, treating the principal threat (leachate in the viscose basins) with ERH, and capping the viscose basins to prevent further infiltration will result in improved groundwater quality. Although it is likely that Alternative D will restore the aquifer to drinking water standards, it will take a considerable amount of time.	Pumping and treating the groundwater and eliminating the principal threat by excavating the viscose material will result in improved groundwater quality. Although it is likely that Alternative E will restore the aquifer to drinking water standards, it will take a considerable amount of time.
RAO 5: Mitigate further releases to ground water of hazardous substances from residual contamination in viscose basins 9, 10, and 11 to ground water.	This alternative will not treat the concentrated leachate and therefore would not achieve RAO 5.	Capping the viscose basins will reduce seepage from the basins to the groundwater. Extraction of the leachates will substantially reduce the source of contamination to groundwater. Alternative C would	Capping the viscose basins will reduce seepage from the basins to the groundwater. Treatment of the leachates with ERH will substantially reduce the source of contamination to groundwater. Alternative D would	Excavating the viscose basins will eliminate the major source of contamination to groundwater. Alternative E would achieve RAO 5.

Table 10 Comparison of Alternatives to Remedial Action Objectives

	Alternative B- P&T GW, Cap VB 9-11	Alternative C – P&T GW & Leachate, Cap VB 9-11	Alternative D- P&T GW, ERH (Insitu treatment of VB solids) & leachate, Cap VB 9-11	Alternative E – P&T GW, Exsitu treatment of VB Solids & remove some Leachate
		achieve RAO 5.	achieve RAO 5.	
RAO 6: Control and mitigate contaminated ground water plume discharge to the river.	Extraction wells will be installed to prevent ground water discharge to the river. Alternative B would achieve RAO 6.	Extraction wells will be installed to prevent ground water discharge to the river. Alternative C would achieve RAO 6.	Extraction wells will be installed to prevent ground water discharge to the river. Alternative D would achieve RAO 6.	Extraction wells will be installed to prevent ground water discharge to the river. Alternative E would achieve RAO 6.
RAO 7: Control the production and uncontrolled release of hazardous and/or noxious gases from viscose basins 9, 10, and 11 that represent an unacceptable risk or public nuisance.	The capping of the viscose basins included a gas vent layer with a gas treatment system (if necessary), preventing accumulation of gases beneath the cap. Alternative B would achieve RAO7.	The capping of the viscose basins included a gas vent layer with a gas treatment system (if necessary), preventing accumulation of gases beneath the cap. Alternative C would achieve RAO7.	Off-gases generated during ERH treatment would be treated using a thermal oxidation unit. Alternative D would achieve RAO7.	Soil freezing technology to freeze the viscose solids and leachates as a semi-solid block will be used to control releases prior to excavation. Alternative E would achieve RAO7.

Table 11

EPA Region 3 Ecologically Protective Backfill Values

Analyte* (mg/kg)	EPA Region 3 backfill
Al	50.0
An	2.7
As	18.0
Ba	330.0
Be	40.0
B	0.5
Cd	3.6
Cr (3/6)	260/1300
Co	13.0
Cu	70.0
Fe	200.0
Pb	110.0
Mn	220.0
Hg(inorg)	0.00051
Ni	38.0
Se	0.52
Ag	42.0
Ti	1.0
Sn	51.5
V	78.0
Zn	120.0
CN	5.0

Compound* (mg/kg)	EPA Region 3 backfill
ACENAPHTHENE	20
ANTHRACENE	0.1
BENZO[A]PYRENE	0.1
BIPHENYL, 1,1-	60
CHLOROANILINE, P-	20
CHLOROBENZENE	0.05
CHLOROPHENOL, 2-	7
DDT and metabolites	0.21
DICHLOROBENZENE, P-	20
DICHLOROPHENOL, 2,4-	20
DICHOLOR-2-BUTENE, 1,4-	1000
DIELDRIN	0.049
DIETHYL PHTHALATE	100
DIMETHYLPHTHALATE	200
DI-N-BUTYLPHTHALATE	200
DINITROPHENOL, 2,4-	20
ETHYL BENZENE	0.05
ETHYLENE GLYCOL	97
FLUORANTHENE	0.1
FLUORENE	30
HEXACHLOROCYCLOPENTADIENE	10
NAPHTHALENE	0.1
NITROBENZENE	40
NITROPHENOL, 2-	7
NITROPHENOL, 4-	7
NITROSODIPHENYLAMINE, N-	20
PAHs, TOTAL	1
PAHs, LMW	29
PAHs, HMW	11
PCBs, TOTAL	0.371
PENTACHLOROBENZENE	20
PENTACHLOROPHENOL	5
PHENANTHRENE	0.1
PHENOL	30
PYRENE	0.1
PYRIDINE	0.1
STYRENE	0.1
TETRACHLORODIBENZOFURAN, 2,3,7,8- (TCDF)	0.00084
TETRACHLORODIBENZO-P-DIOXIN, 2,3,7,8- (TCDD)	0.00000315
TETRACHLOROPHENOL, 2,3,4,6-	20
TOLUENE	0.05
TRICHLOROBENZENE, 1,2,4-	20
TRICHLOROPHENOL, 2,4,5-	4
TRICHLOROPHENOL, 2,4,6-	9
XYLENES (TOTAL)	0.05

For analytes and compounds not listed, use PADEP Safe Fill Standards for Residential Direct Contact

Slight exceedances of these values may be acceptable if the backfill area is spatially limited, the soils are amended with organics to reduce bioavailability, or if toxicity testing of the backfill material demonstrates that it does not pose risk.

APPENDIX A

ARARs For Selected Remedy Avtex Fibers OU-7

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Specification and/or Details Regarding ARARs in the Context of Remediation
Clean Water Act: Federal Ambient Water Quality Criteria	33 U.S.C. 1314	Relevant and Appropriate	These are non-enforceable guidelines published pursuant to Section 304 of the Clean Water Act that set the concentrations of pollutants that are considered adequate to protect human health and aquatic life.	Alternatives B through E involve a discharge of a point source to a water of the United States. All Commonwealth waters are designated for recreational uses, propagation and growth of aquatic life, wildlife, and the production of edible and marketable natural resources. The standards for freshwater aquatic life and non-public water supplies set forth in the Commonwealth's water quality standards would be attained. Those Federal Water Quality Criteria that deal with these designated uses would be attained where a state standard does not exist.
Virginia Water Quality Standards	9 VAC 25-260-140	Applicable	These are criteria to maintain surface water quality.	
Virginia Surface Water Antidegradation	9VAC 25-260-30	Applicable	Requires that, at a minimum, the level of water quality necessary to protect existing uses shall be	These standards would be attained for surface water discharge. The surface waters at issue have not

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Specification and/or Details Regarding ARARs in the Context of Remediation
Policy			maintained and protected. Where water quality exceeds water quality standards, that quality must be maintained and protected, with certain exceptions.	been designated as providing exceptional environmental settings and exceptional aquatic communities or exceptional recreational opportunities within the meaning of 9VAC 25-260-30(A)(3).
Shenandoah River Total Maximum Daily Loads (TMDLs)	9VAC 25-720-50(A) Water Quality Management Planning Regulation - Potomac-Shenandoah River Basin: Total Maximum Daily Loads (TMDLs).	Applicable	This regulation lists the EPA-approved and board-adopted total maximum daily loads (TMDLs), waste load allocations (WLAs), load allocations (LAs) and other water quality management criteria contained in the existing water quality management plans (WQMPs).	The waste load allocation for PCBs for the Avtex Site must be met.
Clean Water Act: National Pollutant Discharge Elimination System Requirements	40 C.F.R. Part 122	Applicable	These are enforceable standards for direct discharge of pollutants to surface waters of the United States.	The substantive federal standards are applicable to the point source discharge. Any more stringent requirements under the VDPES would also be attained. No permits shall be required for on-site discharges. The applicable standards are those in effect at the time the ROD is signed.
Virginia Pollutant Discharge Elimination System (VPDES)	9 VAC 25-32-10 to 940	Applicable	These are standards for discharging pollutants into surface waters of Virginia.	
Safe Drinking Water Act:	40 CFR 141.50 to 141.55; 40 CFR 141.61141.66	Relevant and Appropriate	Under the Safe Drinking Water Act, Maximum Contaminant Levels (MCLs) are enforceable standards for public drinking water supply	The contaminated drinking water at the Site is a potential source of drinking water. Alternatives B through E involve returning this

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Specification and/or Details Regarding ARARs in the Context of Remediation
			systems that have at least 15 service connections or are used by at least 25 persons. Maximum Contaminant Level Goals (MCLGs) are generally more stringent standards developed under the Safe Drinking Water Act that Section 121(d) of CERCLA directs be attained when relevant and appropriate under the circumstances of the release.	groundwater to its beneficial use as a drinking water source. The MCLs are relevant and appropriate for contaminants that are carcinogens and the MCLGs are relevant and appropriate for the noncarcinogenic contaminants in the groundwater. These two standards apply in-situ. See, also, 55 Fed.Reg. 8750-8751 (March 8, 1990).
Virginia Erosion and Sediment Control Regulations	4VAC 50-30-30 4VAC 50-30-40; 4VAC 50-30-50; 4VAC 50-30-60	Applicable/ Relevant and appropriate	4VAC 50-30-30 authorizes standards for construction activities, standards for variance and maintenance requirements, some of which may be directly applicable; in the absence of applicable standards, EPA has determined that the standards set forth in the other cited sections would be relevant and appropriate to all construction activities	Alternatives B through E involve construction activities that would disturb the land. Substantive portions of cited regulations are applicable/relevant and appropriate if more stringent than federal requirements. No permits or plan are required.
Controls on Discharge of Storm Water	40 CFR 122.26	Applicable	Contains requirements for specified categories of storm water discharges	Applicable, substantive standards must be met.
Virginia Stormwater Management Regulations	4VAC 50-60-10, et seq.	Applicable	These regulations establish criteria for management of storm water within Virginia.	Any substantive requirements of these regulations that are more stringent than the federal requirements will be attained. No permits are required.

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Specification and/or Details Regarding ARARs in the Context of Remediation
Virginia General Permit for Impacts from Development Activities Regulation	9VAC 25-690-100	Applicable/	Contains standards for activities impacting up to two acres of nontidal wetlands.	Substantive standards must be met for applicable activities; however, none of the procedural requirements are required to be met.
Virginia Ambient Air Quality Standards: Control of Particulate Matter	9 VAC 5-30-60	Applicable	These regulations establish standards for particulate matter in ambient air.	The substantive requirements of these regulations will be attained. No permits are required.
Virginia New and Modified Stationary Sources: Visible and Fugitive Dust Emissions	9VAC 5-50-20 to 40; 60 to 120	Applicable	These regulations establish standards for visible and fugitive dust emissions from new/modified stationary sources.	The substantive requirements of these regulations will be attained. No permits are required.
Virginia New and Modified Stationary Sources: Odorous Emissions	9VAC 5-50-130-140	Applicable	These regulations establish standards for odorous emissions.	The substantive requirements of these regulations will be attained. No permits are required.
Toxic Substance Control Act	40 CFR 761.61(c)	Relevant and Appropriate	The direct contact soil cleanup standard for PCBs is 25 mg/kg Total.	This cleanup standard is risk-based and is consistent with the substantive standards of 40 CFR 761.61(c). While none of the cleanups levels found in 40 CFR 761.61 are applicable to CERCLA cleanups [see 40 CFR 761.61(a)(1)(ii)], EPA determined that the risk-based cleanup approach found in 40 CFR 761.61(c)

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Specification and/or Details Regarding ARARs in the Context of Remediation
				is relevant and appropriate to this cleanup, and that the 25 mg/kg Total PCB cleanup level will not pose an unreasonable risk of injury to health or the environment
Clean Water Act Section 404 Program	CWA Section 404 40 CFR 230	Applicable	Clean Water Act Section 404 Program	Substantive portions applicable to any activities involving discharge of dredge or fill material to water of the United States, including the onsite wetlands. No permit is required.

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Specification and/or Details Regarding ARARs in the Context of Remediation
Virginia Water Protection Permit Regulations	9VAC 25-210-10 to 260	Applicable	This regulation establishes an application and permit program for approval to dredge, fill or discharge any pollutant into or adjacent to surface waters, withdraw surface water, or otherwise alter the physical, chemical or biological properties of surface waters and make them detrimental to the public, animals, aquatic life, or the use of the water for its intended used. It also restricts certain activities in wetlands.	If any of the substantive requirements of these regulations are more stringent than the federal regulations under CWA Section 404, such requirements would be applicable to any activities in Alternatives B through E that involve dredging of surface waters, filling areas adjacent to surface waters, or altering the physical, chemical or biological properties of surface waters. No permit would be required.

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Specification and/or Details Regarding ARARs in the Context of Remediation
Virginia Hazardous Waste Management Regulations	9VAC 20-60-12 to 50; 9VAC 20-60-260 to 264; 9VAC 20-60-268	Applicable	These regulations establish requirements for the treatment, storage and disposal of hazardous waste. EPA does not have information establishing that Viscose Basins 9-11 contain listed hazardous waste. However, the orange leachate is a characteristic hazardous waste within the meaning of 9VAC 20-60-261, which incorporates by reference the definitions of hazardous waste found in 40 CFR 261 (with an amendment to the definition of universal waste not relevant here), so these regulations are applicable to the active management of that waste. It is not certain whether any particular batch of extracted green leachate would be classified as characteristically hazardous.	Active management (i.e., extraction, treatment and disposal) of the orange leachate and any green leachate that is hazardous must comply with these regulations.

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Specification and/or Details Regarding ARARs in the Context of Remediation
			In addition, Alternatives B through E also call for any drainage channel sediments that are hazardous within the meaning of 9VAC 20-60-261 to be disposed of offsite at a RCRA Subtitle C facility. During the time that any such wastes are managed onsite, these regulations are applicable. (For activities that occur offsite, the remedial action must comply with all applicable federal, state and local laws in effect at the time. ARARs are identified for the onsite portion of remedial activiites	Alternatives B through E would comply with these regulations for the onsite portion of the drainage channel sediment activities

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Specification and/or Details Regarding ARARs in the Context of Remediation
Virginia Solid Waste Management Regulations	9VAC 20-80-10, et seq.; 9VAC 20-80-240 9VAC 20-80-320	Applicable	9VAC 20-80-10 contains definitions which set forth terms which make other portions of these regulations applicable to a given facility; 9VAC 20-80-240 and 9VAC 20-80-320 both contain general provisions applicable to solid waste disposal facilities.	Substantive standards applicable to Viscose Basins 9-11. EPA is invoking 9VAC 20-80-240 and 9VAC 20-80-320 to allow the extraction of the leachate under either : (1) the leachate performance standards contained in Appendix B to this Proposed Plan or (2) the treatment with ERH technology. Thus, C and D meet the requirements of this ARAR. Alternative E meets this ARAR because the leachate is extracted. Alternatives A and B would not meet the requirements of this ARAR because it involves management of the leachate in Viscose Basins 9-11 in a manner not authorized by 9VAC 20-80-240 and 320, under the circumstances of this Site.

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Specification and/or Details Regarding ARARs in the Context of Remediation
Solid Waste Disposal Facility Standards and Surface Impoundments and Lagoons	9VAC 20-80-290, 9VAC 20-80-300, 9VAC 20-80-310, and 9VAC 20-80-380	Applicable	Establishes additional standards for solid waste facilities and, specifically, for lagoons	Applicable to Viscose Basins 9-11
Virginia Solid Waste Management Regulations (VSWMR): Industrial Landfills	9 VAC 20-80-270	Applicable	This regulation includes requirements for industrial landfills, including finished side and top slopes, control of decomposition gases, groundwater monitoring and closure and post-closure requirements.	Enumerated substantive standards apply to Viscose Basins 9-11
- Finished side and top slopes	9 VAC 20-80-270(B)17	Applicable	Establishes maximum and minimum finished slopes that are applicable to industrial landfills	Finished side slopes that are >33% must be supported by stability calculations; minimum top slopes must be ∃2% to prevent ponding.
- Groundwater monitoring, closure	9VAC 20-80-270(D), (E) and (F)	Applicable	Establishes requirements for groundwater monitoring, closure and post-closure care of industrial	Substantive standards apply to alternatives B through E

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Specification and/or Details Regarding ARARs in the Context of Remediation
and post-closure			landfills	
- Control of decomposition gases	9 VAC 20-80-270(F) 1d and 9 VAC 20-80-280	Applicable	If triggered by the standards in 9VAC 20-80-280, post-closure care must include maintaining and operating a gas monitoring system in accord with 9 VAC 20-80-280, which establishes requirements to control and monitor decomposition gases at industrial landfills if certain conditions exist	Explosive gas (methane) concentrations must be maintained <25% LEL in facility structures (excluding gas control or recovery system components) and <LEL at the facility boundary. Systems to control emissions of non-methane organic compounds may be required.
- Leachate control system and monitoring	9 VAC 20-80-290	Applicable	Establishes requirements to monitor and control leachate at solid waste disposal facilities.	Leachate must be treated prior to release to the environment.
- Leachate handling order of preference	9 VAC 20-80-290(D)	Applicable	Preferences are: 1) direct discharge to treatment plant; 2) pump and haul to treatment plant; 3) recirculate (units with composite bottom liners only); or 4) on-site treatment and discharge to stream under a VPDES permit.	No OU-10 units have a composite bottom liner; leachate recirculation is disallowed. Direct discharge to the treatment plant is preferred over either pump and haul or on-site treatment and discharge under VPDES standards.
- Air Emissions Standards for Process Vents; Toxic Air Pollutant Limits	9VAC 20-60-264 9VAC 5-60-200 to 270; 9VAC 5-60-300 to 370	Applicable	9 VAC 20-60-264 pertains to process vents associated with air stripping (and other) operations that manage hazardous wastes with organic concentrations of at least 10 ppmw. The other cited regulations set limits for toxic air pollutants	The treatment system proposed for some of the alternatives may include an air stripper or other unit for managing hazardous wastes.

APPENDIX B

APPENDIX B

PRE-DESIGN INVESTIGATION AND LEACHATE EXTRACTION PERFORMANCE STANDARDS

I. Conduct a pre-design investigation that includes the following elements:

A. Phase I

1. Evaluate remote sensing technologies based on literature, vendor information, and field demonstrations that would be effective in defining the distribution of leachate and void spaces in the viscose basins.

2. Install a bridging layer over the viscose basins to provide a surface that permits access for investigation equipment over the entire Viscose Basins 9, 10, and 11 area.

3. Conduct a full-scale remote sensing field study throughout Viscose Basins 9, 10, and 11 if EPA identifies an appropriate technology.

4. Conduct a Cone Penetrometer Testing (CPT) investigation over a minimum of a 50-foot grid spacing (at least 230 locations) within Viscose Basins 9, 10, and 11 to evaluate void spaces and leachate distribution more completely prior to the installation of extraction wells.

B. Phase II

1. Prepare a table which lists the basin area, nominal depth, estimated volume of viscose waste, estimated viscose matrix (i.e., soft viscose, hard viscose, voids), and estimated volumes of green, mixed, and orange leachate based on the Phase I findings. The leachate estimates shall consist of three separate estimates: a lower bound estimate, a middle estimate, and an upper bound estimate.

2. Based on existing knowledge of the viscose basins, standard vertical wells, supplemented with sumps, will be the most effective means to extract leachate. If EPA determines Steps 1 through 4 under Phase I of the pre-design investigation indicate another technology would be more effective, an evaluation of this technology will be performed. The primary considerations for placement of wells and sumps, or an evaluation of the effectiveness of a technology, will be based on a) being able to be implemented safely by workers, b) the extent to which it can reduce contaminant migration into ground water in the short term and sustain it through the period of leachate extraction, c) the extent to which leachate with suitable characteristics and suitable volumes can be extracted for treatment in the wastewater treatment plant, and d) the total volume of leachate extractable.

C. Leachate Extraction

1. Extraction of "Orange" and "Mixed" Leachate

Standard vertical wells, supplemented by sumps, will be utilized for the extraction of orange and mixed leachate unless EPA determines the pre-design investigation indicates another technology will be more effective. Performance standards for standard vertical wells and sumps are described in this section. If a different technology has been determined to be more effective, EPA will establish performance standards for that technology equivalent to those described here for standard vertical wells and sumps.

a. A well (or wells) designed to extract orange leachate and mixed leachate separately (to the extent that is possible) shall be installed at a total of 170 locations in the basin. Although not required, it is assumed that if separate wells are necessary for mixed and orange leachates, they will be nested wells that are close to each other. A sump may be used to replace a well(s) in a given location. The details of the distribution of the wells among the basins will be determined in the design phase using the data from the pre-design investigation to assist in determining appropriate locations for wells. Well locations will be established throughout the basins, unless the preliminary design studies do not identify appropriate locations throughout the basins. In addition to the new wells, the existing wells installed in 2000/20001 (WP-01 through WP-09) shall be used.

b. Evaluation of Effectiveness of Mixed and Orange Leachate Extraction using Wells

   The wells will be pumped to collect data over a sufficiently long period to estimate the volume of leachate that can be extracted from each well if pumped for 18 months. Intermittent periods of pumping and recharging will likely be necessary. If it is shown that at least 25 percent of the lower bound estimate of the volume of a type of leachate (orange leachate or mixed leachate) in a basin cannot be extracted from standard vertical wells and sumps by pumping each well or sump for 18 months, extraction of that type of leachate from that basin using will be considered impracticable, and pumping will be stopped (i.e., move on to containment portion of the remedy). A sump will be considered equivalent to one well for the purpose of evaluating the effectiveness of extraction. Mixed and orange leachate extraction will be estimated and evaluated separately. If it is estimated that at least 25 percent of the lower bound estimated leachate volume can be pumped from the wells and sumps by pumping each well or sump for 18 months, then extraction of leachate shall continue. Periodically, the volume of leachate that can be extracted will be re-estimated to see if extraction of at least 25 percent of the lower bound estimated leachate volume is achievable.

   Ineffective well or sump: A well or sump will be considered to be ineffective if the volume of leachate that can be extracted from it is less than a threshold volume. The threshold volume will be calculated as ¼ the average extraction rate (in gallons per day [gpd]) required to achieve 25 percent extraction of the leachate type in a basin over a pumping period of 18 months, as follows:

0.25 X $\dfrac{\text{Low Estimate of Volume of Leachate Type x 0.25}}{\text{Number of Pumping Wells x Pumping Days}}$

Where:

Low Estimate of Volume of Leachate = The lower bound estimated volume of mixed or orange leachate within the basin.

Number of Pumping Wells = the number of wells installed within the basin being used for extraction at the time of the calculation.

Pumping Days = 5 days/week times 50 weeks per year times 1.5 yrs. = 375 days

At EPA's discretion, once the actual conditions are encountered, EPA can increase the threshold value for determining an ineffective well up to the average extraction rate, rather than ¼ of the average extraction rate.

Extraction of leachate from a well or sump can be discontinued if the concentration of contaminants in the well, divided by the dilution attenuation factor (DAF) of 5, such that the cumulative excess lifetime cancer risk is less than one in ten thousand (1 X 10^{-4}), reducing non-cancer risks to a Hazard Index (HI) of 1 (or less) for each specific organ, and Maximum Contaminant Levels (MCLs) for carcinogens and non-zero Maximum Contaminant Level Goals (MCLGs) for non-carcinogens are not exceeded (ROD Table 7).

The DAF of 5 was derived using two approaches: a) Estimating the DAF using the dilution factor model described in EPA's "Soil Screening Guidance: User's Guide (July 1996), and b) Comparing concentrations of contaminants in leachate within the basins to the concentrations of the contaminants in wells adjacent to the basins. The more conservative (e.g. less degradable) compounds were used. Both approaches resulted in DAFs of approximately 5.

2. Extraction of Surface /Green Leachate

Extraction of surface/green leachate will be performed by using sumps to collect the leachate for treatment. Extraction of leachate can be discontinued if, after applying a DAF of 5, the concentration of contaminants in surface/green leachate zone meets the risk levels for restoration of the aquifer such that the cumulative excess lifetime cancer risk is less than one in ten thousand (1 X 10^{-4}), reducing non-cancer risks to a Hazard Index (HI) of 1 (or less) for each specific organ, and MCLs for carcinogens and non-zero MCLGs for non-carcinogens are not exceeded (ROD Table 7).

APPENDIX C

LIST OF ACRONYMS

ARARs	Applicable or relevant and appropriate requirements
BOD	Biological Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS ID	Comprehensive Environmental Response, Compensation and Liability Information System Indentification
CFR	Code of Federal Regulations
COCs	Contaminants of concern
COD	Chemical Oxygen Demand
COPCs	Contaminants of potential concern
DAF	Dilution Attenuation Factor
DAPL	Dense aqueous phase liquid
EDA	Economic Development Authority
EPA	U.S. Environmental Protection Agency
ERH	Electrical Resistance Heating
FS	Feasibility study
HI	Hazard Index
HQ	Hazard Quotient
ICs	Institutional controls
ICIAP	Institutional Control Implementation and Assurance Plan
LDPE	Low Density Polyethelene
M	Million
MCL	Maximum Contaminant Level
MCLGs	Maximum Contaminant Level Goals
Mgal	Million gallons
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NTCRA	Non-time Critical Removal Action
O&M	Operation and maintenance
OSWER	EPA's Office of Solid Waste and Emergency Response
OUs	Operable Units
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
ppm	parts per million
PVC	Polyvinyl Chloride
PRPs	Potentially Responsible Parties
RA	Risk Assessment
RAGS	Risk Assessment Guidance for Superfund
RAOs	Remedial action objectives

RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	Reference dose
RI/FS	Remedial Investigation and Feasibility Study
RME	Reasonable maximum exposure
ROD	Record of Decision
SPLP	Synthetic Precipitation Leaching Procedures
TBC	To be considered
TDS	Total Dissolved Solids
USFWS	U.S. Fish and Wildlife Service
VAC	Virginia Administrative Code
VADEQ	Virginia Department of the Environmental Quality
VDOH	Virginia Department of Health
VOCs	Volatile organic compounds
VPDES	Virginia Pollution Discharge Elimination System
VSWMR	Virginia Solid Waste Management Regulations
WWTP	Wastewater Treatment Plant